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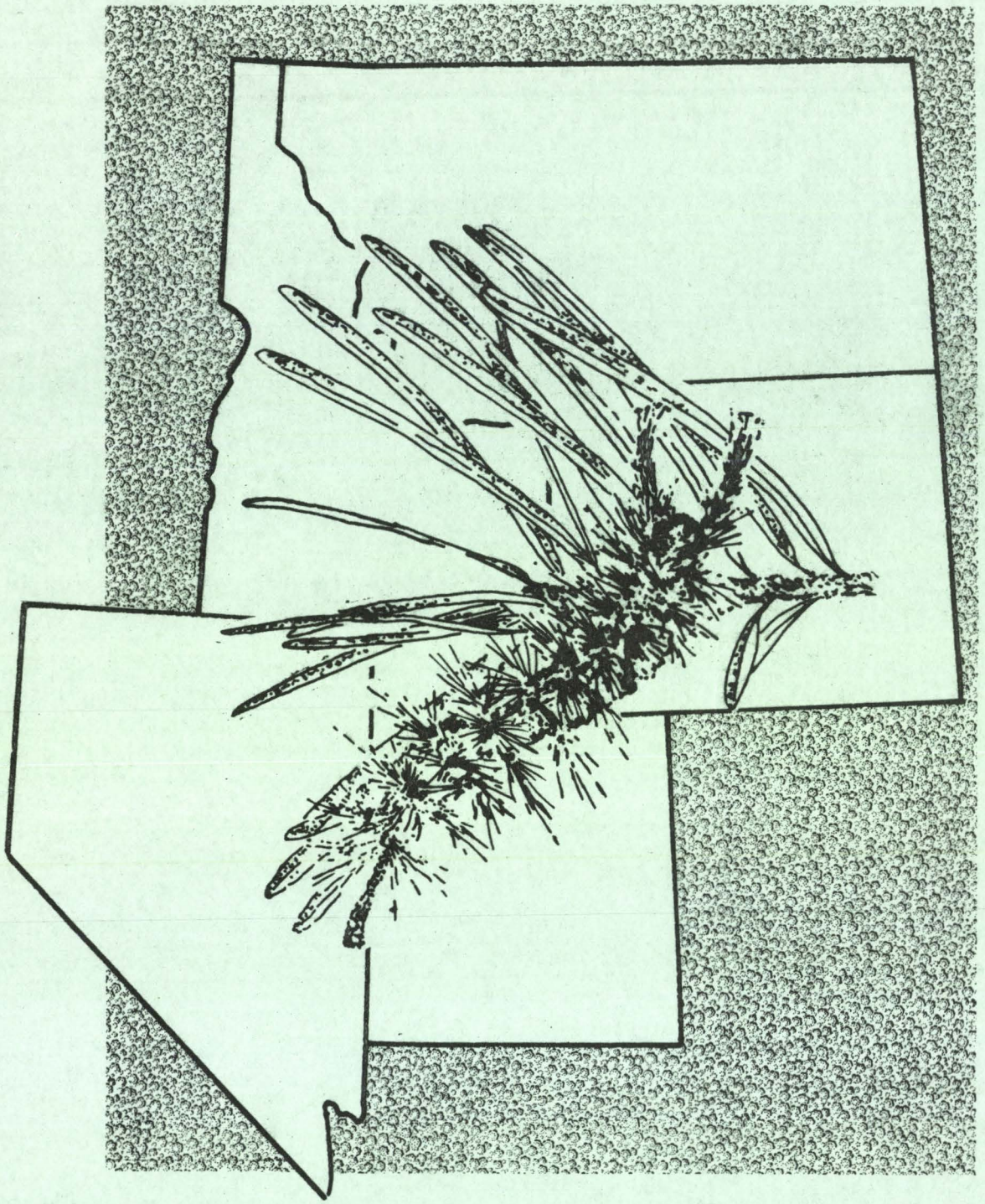
History of Douglas-Fir Tussock Moth and Related Suppression Efforts in the Intermountain and Northern Rocky Mountain Regions - 1927 Through 1984



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HISTORY OF DOUGLAS-FIR TUSSOCK MOTH AND RELATED SUPPRESSION EFFORTS IN THE INTERMOUNTAIN AND NORTHERN ROCKY MOUNTAIN REGIONS 1927 THROUGH 1984

by

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INTRODUCTION

The Douglas-fir tussock moth (DFTM), Orgyia pseudotsugata McD., periodically defoliates stands of coniferous trees in forests of the western United States. Recorded hosts are Rocky Mountain Douglas-fir, Pseudotsuga menziesii var. glauca (Beissn.), Franco; grand fir, Abies grandis (Dougl.) Lindl.; white fir, A. concolor (Gord. & Glend.) Lindl; subalpine fir, A. lasiocarpa (Hook.) Nutt.; and Engelmann spruce, Picea engelmannii Parry. When preferred food is depleted, tussock moth larvae will consume the foliage of most adjacent conifers and sometimes even brush species. Both new and old needles are fed upon; consequently, heavy larval populations are capable of completely defoliating and killing trees in a single growing season. Next to the western spruce budworm, Choristoneura occidentalis Freeman, the tussock moth is the most important defoliator of Douglas-fir and true firs in Idaho and Montana.

In 1906, the DFTM was identified for the first time in America on the Sierra National Forest, California (Eaton and Struble 1957). In 1918, a species of tussock moth severely defoliated Douglas-fir near Chase, British Columbia, Canada. Blackmore identified it as Hemerocampa vetusta gulosa Hy. Edw. However, McDunnough, in 1921, described it as a new species, H. pseudotsugata McD., based on the color of larval tufts and feeding habits (Balch 1930). Ferguson (1978) noted that American species of tussock moths were being placed in the genera Notolophus or Orgyia, and Hemerocampa. He stated that division of the species into these different genera was untenable, and the oldest name, Orgyia, should be used for all species. The first DFTM infestation in the United States was recorded in 1927 when subalpine fir was defoliated on the Humboldt National Forest at Jarbidge, Nevada (Balch 1930). Since then, major epidemics have occurred every decade in the fir forests of western North America (Wickman et al. 1973; Tunnock 1973). Tree mortality and top killing can still be seen in some old outbreak areas.

Information presented in this report was compiled from unpublished and published reports, and data from Forest Service files in Missoula, Montana, and Boise, Idaho.

LIFE HISTORY AND HABITS

The DFTM overwinters in the egg stage. Eggs usually hatch in June and emerging larvae feed on the underside of new needles. Newly emerged larvae are about one-eighth inch (3.175 mm) long, gray, and have long hairs. Their lightweight, long hairs, and silken webs allow them to be readily transported by the wind. It is believed that outbreaks develop in place from resident populations rather than from windborne larvae (Wickman et al. 1971).

Larvae go through five or six growth stages or instars, and reach about 1-1/4 inches (31.75 mm) in length. Current year's needles are needed by the early instars, whereas late instars can also feed on old needles. Feeding may last until late July. Larvae then weave a cocoon of silken webbing mixed with body hair in which to pupate. Pupae are often found in large masses on branches and trunks of host trees, ground plants, rocks, boards, or other surfaces. Eaves of buildings near infested areas are favorite pupation sites.

Moths emerge from cocoons in August, about 10 to 18 days after pupation. Because females are wingless, they remain on their cocoons where, following mating, they deposit their eggs. Male moths are winged and good fliers.

HISTORY OF OUTBREAKS

The history of outbreaks in Nevada, Idaho, and Montana is summarized in appendix Table 1.

Nevada

1927-1929.--The first documented DFTM outbreak in the United States was discovered on subalpine fir near Jarbidge, Nevada in 1927 (appendix figure 1). By 1929 the entire Jarbidge Canyon was infested (Balch 1930).

1938.--In 1938 an outbreak occurred on the Humboldt National Forest at the heads of West Mary's River and Camp Creek (appendix figure 1). Subalpine fir of relatively low commercial value was defoliated (Farrel 1938). Haycock (1938) collected larvae and cocoons from the Mary's River, Camp Creek, and West Jarbidge drainages at elevations of approximately 8,700 feet (2,652 meters).

1959.--Over 5,000 acres (2,023.5 hectares) of white fir were defoliated by DFTM on the Humboldt National Forest near Wheeler Peak in 1959 (appendix figure 1). The infestation occurred on the east side of the Snake Range from south of Chokecherry Creek to the North Fork of Big Wash Canyon at elevations of 7,200 to 9,000 feet (2,195 to 2,743 meters). Extensive tree mortality resulted in the upper portion of the type in rocky terrain. Populations persisted from 1955 to 1959 in the area (Washburn 1959).

1960.--An infestation was detected in white fir on Highland Peak near Pioche, Nevada in 1960 (appendix figure 1). It had apparently been in progress for 3 to 4 years. A late fall evaluation found higher than average egg parasitism, predation, and incidence of virus disease (Washburn and Cole 1960).

The infestations at Wheeler Peak and Highland Peak dropped to low levels in 1960 apparently due to parasites and virus (Knopf 1961).

1961-1962.--White fir stands on the Humboldt National Forest near Jarbidge were defoliated in 1961 and 1962 (appendix figure 1). By 1962 approximately 47,000 acres (19,021 hectares) were lightly defoliated, 5,000 acres (2,024 hectares) moderately defoliated, and 7,000 acres (2,833 hectares) heavily defoliated for a total of 59,000 acres (23,877 hectares). Reproduction was severely affected in heavily defoliated areas (Washburn and Honing 1962).

1963.--The infestation in the Humboldt National Forest near Jarbidge, which infested white fir stands from 1960 through 1962, was apparently controlled by native egg parasites and virus. Very few viable egg masses were found in 1963 in the Jarbidge area (Anonymous 1963).

1968-1971.--One small white fir was moderately defoliated in 1968 in Kyle Canyon, Las Vegas Ranger District, Toiyabe National Forest. No other defoliation could be found. In 1971 an infestation which destroyed nearly all current foliage on white fir was found at the Bonanza Boy Scout Camp, also on the Las Vegas Ranger District (appendix figure 1) (Trostle 1973).

1972.--In 1972, 60 acres (24 hectares) of white fir and Douglas-fir were defoliated on Virgin Peak (appendix figure 1), public domain lands administered by the Bureau of Land Management (BLM) in Clark County east of Mesquite, Nevada (Trostle 1983).

1973-1974.--An area of 775 acres (314 hectares) was defoliated around Bonanza Boy Scout Camp, Toiyabe National Forest, in 1973 (appendix figure 1). The ratio of new to old egg masses indicated a population decline. White fir mortality resulted from a combination of factors including bark beetle attack, infection by dwarf mistletoe, and defoliation by DFTM (Trostle 1973). In 1974, the white fir in the Camp Bonanza area was defoliated again. Eighty percent of the new foliage displayed some feeding. A fall pupae and egg mass survey showed populations to be very low (Anonymous 1974B).

Idaho

Periodic outbreaks of the Douglas-fir tussock moth in Idaho have been recorded from 1928 to 1984. Areas containing defoliation during each outbreak are illustrated in appendix figures 2 to 15 and a summary of all the outbreak areas is shown in appendix figure 19.

1928-1929.--Three areas of defoliation were noted on the Weiser National Forest in 1928. One was located west of Round Valley, another west of Tamarack, and the third a few miles south of New Meadows. The outbreaks lasted for 2 years and were termed exceedingly destructive. Practically all of the Douglas-fir within the infested areas were destroyed (Evenden 1932). In 1928, on the Boise National Forest, approximately 500 acres (200 hectares) were defoliated in the Bounds Creek drainage (Anonymous 1929) (appendix figure 2). In 1928, an infestation was also found at the Craters of the Moon National Monument (Balch 1930).

1935-1939.--An outbreak was detected in 1935 in the Wood River drainage on the Sawtooth National Forest. Considerable Douglas-fir reproduction and mature timber were killed before the outbreak collapsed in 1939 (Anonymous 1974B). Farrel (1938) also reported an occurrence of DFTM on the Sawtooth National Forest as well as on the Lemhi National Forest in 1938.

1944-1945.--Spot infestations in ornamental and shelterbelt trees around farms and residences appeared in 1944 in northern Idaho. These spots were located at Rathdrum, Troy, Moscow Mountain, and Sandpoint. Additional spot infestations were recorded in 1945 near Farragut, Coeur d'Alene, Rathdrum, Worley, and Genesee. Also, about 320 acres (130 hectares) of grand fir type were defoliated near Viola (Evenden and Jost 1946).

1946.--An aerial survey of the St. Joe National Forest showed defoliation was visible over 350,000 acres (141,645 hectares) in Clearwater, Latah, and Benewah Counties (appendix figure 3). Host types were Douglas-fir, grand fir, and Engelmann spruce. A ground survey showed approximately 447,000 acres (180,901 hectares) were infested with variable population levels of tussock moth larvae (Evenden and Jost 1946).

The Sawtooth National Forest reported in their "Annual Insect Report for 1946" that several areas of defoliation were observed in the Big Smokey country.

1947.--About 395,535 acres (160,073 hectares) were infested in Clearwater, Latah, and Benewah Counties (appendix figure 3) (Evenden and Jost 1947). Another outbreak was located in the summer of 1947 on some 20,000 acres (8,094 hectares) east of Orofino (appendix figure 4). A combination of virus and parasites terminated this infestation before moths could emerge in late summer (Johnson 1949).

1949-1951.--Local residents reported several small areas of Douglas-fir defoliated in 1949 and 1950 in Owyhee County. By 1951, complete to nearly complete defoliation resulted on 10,000 to 12,000 acres (4,047 to 4,856 hectares) (appendix figure 5). Nearly all larvae died before reaching maturity in 1951 (Orr 1952).

1955-1956.--In 1955, 30,600 acres (12,384 hectares) had various degrees of defoliation east of Orofino (appendix figure 4). This infestation subsided by the end of summer, partly due to 78 percent parasitism of prepupae and pupae (Dodge 1956). An active infestation in 1956 was reported on several hundred acres near Plummer (Anonymous 1956).

1956-1959.--Detection surveys revealed that the same area of second-growth Douglas-fir which displayed defoliation in 1951 was defoliated again in 1956 in Owyhee County. The infestation occurred over 10,000 acres (4,047 hectares) (appendix figure 5). Observations indicated a high degree of parasitism (Anonymous 1957). Cole (1958) reported defoliation ranged up to 70 percent.

Populations continued to defoliate Douglas-fir in the Owyhee Mountains in 1957 (appendix figure 5). Defoliation was 52 percent at Silver City, 50 percent at South Mountain, and light at Delamar Mountain. Sixteen pupal cases per 15-inch (38.1-cm) twig were found at South Mountain and nine per twig at Silver City. Pupal parasitism averaged 20 percent. Populations of DFTM at Silver City and South Mountain contained high levels of disease, whereas Delamar Mountain samples appeared disease free (Cole 1958). The area defoliated in Owyhee County totaled 26,000 acres (10,522 hectares) in 1957 (Anonymous 1958).

Dr. E. A. Steinhaus, Berkeley, California, confirmed the disease in the Owyhee DFTM population to be nucleopolyhedrosis virus in 1958.

Defoliation declined to 5 percent at Silver City and 14 percent at South Mountain in 1958, but increased to 73 percent at Delamar Mountain. Pupal cases per 15-inch (38.1-cm) branch dropped to zero at Silver City and South Mountain and were only 0.5 at Delamar Mountain. No mortality of Douglas-fir due to tussock moth was observed in 1957 or 1958 (Cole 1958).

A low population occurred in one small drainage in Owyhee County in 1959 (Anonymous 1960).

1961-1962.--In 1961, Douglas-fir, grand fir, and ornamental spruce trees near farms and private homes were heavily defoliated in Moscow, Clark Fork, and Bonners Ferry (Tunnock 1962). In 1962, aerial surveys of northern Idaho detected infested trees in or near Copeland, Moyie, Albeni Falls, Hayden Lake, Coeur d'Alene, St. Maries, Orofino, and North Bonners Ferry (appendix figure 19). The grand fir trees which had been infested in Clark Fork in 1961, were defoliated again in 1962. Personnel of the Palouse Ranger District, St. Joe National Forest, detected small numbers of larvae in some of their forested areas (Tunnock 1963A). Douglas-fir along the Middle Fork of the Boise River, and in the Swanhom and Dutch Creek drainages on the Boise National Forest (appendix figure 2) were defoliated in 1962. Heavy defoliation occurred over 5,000 acres (2,024 hectares), and medium to light defoliation over 6,000 acres (2,428 hectares). Egg mass counts indicated the infestation was on the increase; however, a few larvae were suspected to have been killed by virus (Washburn and Honing 1962).

1963.--Two newly infested areas were located in northern Idaho in 1963 in addition to those detected in 1962. Current year egg masses were found on six ornamental trees around a home near Algoma Lake south of Sandpoint, and in forested areas near Mineral Mountain Lookout, north of Potlatch (Tunnock 1963B). The infestation on the Boise National Forest (appendix figure 2) increased to 60,000 acres (24,282 hectares) in 1963. Infestations occurred mainly along the Middle Fork and North Fork of the Boise River (Anonymous 1963).

Douglas-fir in the Silver City and South Mountain areas of Owyhee County in southwest Idaho (appendix figure 6) was defoliated in 1963. Light to moderate defoliation occurred over 12,000 acres (4,856 hectares). Heavy defoliation was reported over widely scattered areas which totaled 4,000 acres (1,619 hectares). Douglas-fir in heavily defoliated areas had the upper half of the crowns nearly stripped of needles and the lower half heavily defoliated. Virus counts were high and egg mass counts were low (Anonymous 1963). Defoliation occurred southwest of War Eagle Mountain in Flint Creek and drainages adjacent to Silver City, Idaho (Anonymous 1964).

1964.--Defoliation visible from the air covered about 70,000 acres (28,329 hectares) in Benewah and Latah Counties in 1964. Ground surveys disclosed that the epidemic extended from Moscow to Coeur d'Alene Lake and covered a total of 191,000 acres (77,298 hectares) (appendix figure 7). Several new spot

infestations appeared near Spirit Lake, Rathdrum, Hauser Lake, and Mica (appendix figure 8). Tussock moth populations gradually subsided by 1964 in the following towns due to spraying or natural causes: Moscow, Orofino, St. Maries, Algoma Lake, Albeni Falls, Coeur d'Alene, Moyie, and Clark Fork (Tunnock 1964).

The infestation along the North and Middle Forks of the Boise River, Boise National Forest (appendix figure 2), appeared to have dropped to low levels in 1964. Only one lightly defoliated area of 400 acres (162 hectares) was detected along the Queens River. Tussock moth populations collapsed by the end of the season. Egg parasites and virus were thought to be responsible for the collapse. No new egg masses were found (Anonymous 1964).

In 1964, approximately 3,200 acres (1,295 hectares) of Douglas-fir in Owyhee County were classified as lightly to moderately defoliated. A mosaic of heavy defoliation was observed throughout the infestation area. The infestation in Owyhee County was reported in the South Fork of Boulder Creek and Coyote Creek and along the east side of South Mountain (appendix figure 6). Defoliation was most severe in the upper one-third of the crowns and decreased toward the base of the crowns. Reproduction in pole-sized trees suffered the most severe damage (Anonymous 1964).

1965.--Visible defoliation increased to 225,000 acres (91,058 hectares) in Benewah and Latah Counties in 1965 (appendix figure 7). About 120,000 acres (48,564 hectares) of this infestation were sprayed with DDT. During the fall, few 1965 egg masses or cocoons could be found in any infested areas in northern Idaho. Those found were on the Palouse Ranger District northeast of Moscow. Infestations died out due to virus, and dipterous and hymenopterous parasites. For instance, by August 13, virus killed 64 percent of 125 larvae collected on July 29 near Moscow. A tachinid fly and five species of wasps were very abundant and parasitized many larvae in the Moscow area (Tunnock 1965).

Two infestations occurred in Owyhee County, southwest Idaho (appendix figure 6), on Douglas-fir in 1965. One infestation near South Mountain covered 1,500 acres (607 hectares). This population was declining due to virus. The other infestation, in the North Fork of Boulder Creek, southeast of Silver City, occurred over 2,000 acres (809 hectares). Defoliation was relatively heavy but new egg masses were few. The larval population was substantially reduced by the native virus and was expected to be low in 1966 (Klein and McGregor 1966).

1966.--The infestation in Owyhee County (appendix figure 6), southwest Idaho, declined to 600 acres (243 hectares) in 1966. The infestation occurred southeast of Silver City on the North Fork of Boulder Creek. The infestation was thought to have declined due to virus (Klein 1967).

1970.--Mature Douglas-fir stands on public domain lands administered by the BLM, State, and privately managed lands in Owyhee County, southwest Idaho (appendix figure 9), again exhibited defoliation in 1970. The defoliation was heavy in several localized areas southwest of Silver City, and the infestation was expected to increase in 1971 (Parker et al. 1972).

1971.--Heavy defoliation was observed in 1971 on mature Douglas-fir on State, private, and public domain lands in Owyhee County, southwest Idaho (appendix figure 9). A native virus severely reduced the larval population and only light defoliation was expected in 1972 (Parker et al. 1972).

Ornamental grand fir, spruce, and Douglas-fir were defoliated around several homes in Coeur d'Alene in 1971 (Tunnock and Honing 1971).

1972.--An outbreak in 1972 was recorded near South Mountain (appendix figure 9) on State and private lands in Owyhee County, southwest Idaho. In this infestation, Douglas-fir stands were moderately defoliated (Parker 1973).

Also in 1972, ornamental trees were defoliated at 12 residental sites in Coeur d'Alene, at one home in Troy, and in Post Falls and Moscow. Some damage was seen along the Wolf Lodge Road east of Coeur d'Alene. New egg masses were numerous within a 100-acre (40-hectare) logging area on Charles Butte, St. Joe National Forest (Tunnock 1972).

1973.--Infestations increased in 1973, and aerial surveys of northern Idaho showed defoliation was visible on 70,000 acres (28,329 hectares) of grand fir type within Benewah and Latah Counties on the St. Joe National Forest and adjoining State and private lands (appendix figure 10). There were about 1,800 acres (728 hectares) defoliated on the Coeur d'Alene National Forest and adjoining ownerships (appendix figure 11) and 120 acres (49 hectares) of timber on private land east of Orofino. The Nezperce National Forest contained 23,000 acres (9,308 hectares) of defoliation; another 4,000 acres (1,619 hectares) of timber on private land south of Lewiston (appendix figure 12) were also defoliated. Altogether, about 99,000 acres (40,065 hectares) of visible defoliation occurred in northern Idaho during 1973 (Tunnock et al. 1973). Growth loss and mortality were studied by Bousfield and Ward (1976) in two Douglas-fir stands defoliated in 1973 on the Nezperce National Forest, Idaho. Two years after defoliation, 1,088 board feet per acre, or 16.8 percent of the green stand had been killed in the Lucile Creek drainage, and 3,238 board feet per acre, or 17.6 percent of the green stand was killed in Race Creek. Net growth was reduced 30.7 percent in Lucile Creek and 30.9 percent in Race Creek.

Scattered pure stands of Douglas-fir were defoliated in 1973 on the Sawtooth National Forest and other intermingled and contiguous ownerships (appendix figure 13). Approximately 11,000 acres (4,452 hectares) were defoliated from Featherville to Little Wood Reservoir. Moderate to heavy defoliation occurred and, with one exception, populations collapsed from virus and parasites. Collecting and rearing DFTM pupae from three sites showed pupal parasitism ranged from 75 to 98 percent and averaged 81 percent. Moths emerged from only 2 percent of the pupae collected during the survey (Knopf 1973).

1974.--Aerial survey of northern Idaho in 1974 showed defoliation visible on approximately 115,000 acres (46,541 hectares) of mixed ownerships intermingled with the Clearwater, Coeur d'Alene, Nezperce, and St. Joe National Forests (Hamel and Dooling 1975).

Tussock moth mortality from various causes was monitored within 18,867 infested acres (7,635 hectares) southeast of Coeur d'Alene in 1974 (appendix figure 11). Observations began June 27 when about 50 percent of the larvae were second instars and continued until pupation. Within a 35-day period, there was a 93 percent average reduction in population. Approximately 36.7 percent of the popultion that was collected, then reared in the laboratory, died from unknown causes; 11 percent was parasitized; and 3.4 percent was killed by nucleopolyhedrosis virus. Thirteen hymenopterous parasites were identified with Phobocampe, a new species, the most abundant. It parastized all instars. Unlike most other outbreaks, this one did not collapse at the end of 3 years due to virus and parasites. Egg masses were found in infested areas during the fall of 1974, but defoliation was not visible in 1975 (Tunnock et al. 1976).

Infestation in southern Idaho on Sawtooth National Forest, public domain lands administered by the BLM, State, and private lands (appendix figure 13) declined precipitously in 1974. However, one 1,200-acre (486-hectare) block near Fairfield contained sufficient egg masses to allow potentially significant defoliation.

1975.--No defoliation was visible from the air in northern Idaho. However, in the city of Coeur d'Alene, several ornamental trees were infested (Tunnock and Dooling 1976).

Yard trees on a farm near Rupert sustained top damage in 1975 from a localized infestation that had persisted for several years. Defoliation was most apparent on white fir, somewhat less on ornamental spruce, and least on subalpine fir (Valcarce 1976).

1976.--Light to moderate defoliation of Douglas-fir and subalpine fir was observed on approximately 10,000 acres (4,047 hectares) in the Boulder Creek, Sinker Creek, and Jordan Creek drainages, Owyhee County (appendix figure 14). Ground sampling revealed a high incidence of virus in the larval population. A fall egg mas survey indicated larval population would be low in 1977 (Moyer 1977).

1978.--Larvae were collected from a 35-foot (10.6-meter) defoliated blue spruce in Boise, Idaho (Helzner and Moyer 1978).

1980.--Defoliation was reported on ornamental spruce trees on a farm just north of Grangeville, Idaho (Livingston et al. 1981).

1981.--Light to moderate defoliation of Douglas-fir was observed on approximately 160 acres (65 hectares) in the East Fork of Flint Creek and Jordan Creek in the Owyhee Mountains (appendix figure 15). A single ornamental spruce in Hailey, Idaho was the only other defoliation reported (Anonymous 1981). Larvae were reported on Copper Mountain west of Coeur d'Alene, Idaho and inthe eastern sector of the Clearwater National Forest (Anonymous 1982).

1982.--Incidences of yard and farmstead trees being defoliated increased sharply in 1982. Ornamental trees were infested near or in the towns of Boise, Shoshone, Gooding, Hailey, Hayden Lake, Coeur d'Alene, Plummer, Genesee, 3-1/2 miles south of Genesee in trees along Highway 95, in Craigmont, and in several other small towns between Lewiston and Grangeville (Dewey et al. 1983, Thier and Hoffman 1982). Douglas-fir defoliation in the Owyhee Mountains expanded to 4,000 acres (1,619 hectares). Moderate to heavy defoliation was observed around South Mountain, Little Sawmill Creek, Dewey Peak, Washington Gulch, and Flint Creek (appendix figure 15) (Thier and Hoffman 1982).

1983.--Defoliation was detected on ornamental trees in Hayden Lake, Coeur d'Alene, Moscow, south of Genesee along Highway 95, Craigmont, and Nezperce (Gibson et al 1984). Defoliation of Douglas-fir in the Owyhee Mountains was detected over 14,200 acres (5,749 hectares) with predominantly heavy defoliation (appendix figure 15). Early instar larval populations were categorized as being at low to outbreak levels (Thier and Mocettini 1984). Elsewhere, early instar larval populations were at suboutbreak levels (Dewey et al. 1985). Only one new egg mass was found statewide during fall egg mass surveys which indicated the population had collapsed (Dewey et al. 1985, Thier and Mocettini 1984).

1984.--In northern Idaho, no visible defoliation was detected in forested areas, but occurred in ornamentals in two areas. One spot was along Highway 95 south of Genesee which has had tussock moths for several years. At the USDA Forest Service Tree Nursery in Coeur d'Alene, several ornamental spruce trees were defoliated, but were sprayed with an insecticide. Egg masses were found in the forest (from Moscow north to Plummer) for the first time since the end of the 1973-74 outbreak in the Palouse District. They were on six plots: Mineral Mountain (some light feeding occurred), Long Creek (1 mile NW of Mineral Mountain), Flat Creek, Vassar Meadows, and Big Meadow Creek (Dewey et al. 1985). As predicted by evaluations conducted in the fall of 1983, the 3-year-old infestation in the Owyhee Mountains collapsed with no current defoliation recorded during aerial surveys. Defoliation by the tussock moth was not noted elsewhere in the forests of southern Idaho (Knapp 1985).

Montana

Outbreaks of the DFTM from 1963 to 1976 are illustrated in appendix figures 16 to 18. A summary of all areas in Montana that have contained defoliated trees is shown in appendix figure 20.

1956.--The DFTM was first reported in Montana in 1956 when about 1,000 acres (405 hectares) of Douglas-fir were infested on the west shore of Flathead Lake in Lake County. This outbreak subsided early in August 1956 due to virus and parasites (Anonymous 1956).

1963.--About 1,400 acres (567 hectares) of Douglas-fir were heavily defoliated southwest of Kalispell in 1963 (appendix figure 16). Virus killed most of the larvae in the northern portion of this infestation during the summer, but egg masses were abundant in the southern end that fall. A light population infested about 10 acres (4 hectares) of timbered land surrounding Lion Lake near Hungry Horse, but no 1963 egg masses were found that fall (Tunnock 1963B).

1964.--The number of acres defoliated southwest of Kalispell increased to 4,800 (1,920 hectares) in 1964 (appendix figure 16). The virus almost eliminated the population by August. Two gallons of diseased larvae were collected from which polyhedra were extracted to be used as a spray.

In Lake County, southwest of Polson (appendix figure 16), 250 acres (101 hectares) of Douglas-fir were moderately defoliated, and three small groups were heavily defoliated around Bigfork. Virus drastically reduced the Bigfork population and by September this outbreak subsided. Four gallons of diseased larvae were collected from the three areas for polyhedra extraction. Spot infestations were detected in Troy, Tally Lake, Bonita, and south of Columbia Falls (appendix figure 20). A few ornamental spruce were defoliated in Missoula (Tunnock 1964).

1965.--Only about 50 of the 250 acres (20 of the 101 hectares) infested in 1964 were defoliated in 1965 southwest of Polson. Three 10- to 40-acre (4- to 10-hectare) areas of Douglas-fir mixed with ponderosa pine were lightly defoliated south of Elmo (appendix 16). No current egg masses or cocoons were found in the Polson or Elmo infestations in October 1965. This indicated larvae died before pupating (Tunnock 1965).

1970-1971.--Tussock moth activity was detected again in 1970 when a few ornamental spruce trees were defoliated in Polson and Missoula. Egg masses were found on these trees in October 1971 (Tunnock and Honing 1971), but no feeding occurred in 1972 (Tunnock 1972).

1973.--Aerial detection surveys during the summer showed two areas of Douglas-fir were defoliated near Missoula. One was in the Worden Creek drainage near Lolo and the other was south of Frenchtown (appendix figure 17). Hos trees on approximately350 acres (142 hectares) were defoliated (Tunnock et al. 1973).

1974.--The infestation near Lolo spread to 200 acres (81 hectares) and the one south of Frenchtown increased to 800 acres (324 hectares) (figure 17). During the summer, DFTM populations were reported on Douglas-fir in the lower Flathead Valley in Lake County. An aerial survey revealed that 4,796 acres (1,941 hectares) were lightly to heavily defoliated north of Polson (appendix figure 18). Two spot infestations, south of St. Ignatius and west of Ravalli (appendix figure 18), totaled about 60 acres (24 hectares) of visible (appendix figure 18) defoliation (Tunnock et al. 1974).

1975.--Defoliation was detected on 10 acres (4 hectares) of Douglas-fir near Missoula. The infested area north of Polson was monitored to determine degree of tussock moth mortality. It was found that parasites killed 7.7 percent, nucleopolyhedrosis virus 48.6 percent, and unknown factors killed 43.4 percent of the population. Very few egg masses were found in the area that fall (Tunnock and Dooling 1976). Defoliation was visible again on 20 acres (8 hectares) south of St. Ignatius and on 40 acres (16 hectares) west of Ravalli (Kohler 1976A).

1976.--Light populations were present in the 20-acre (8-hectare) area south of St. Ignatius. A small field test of four insecticides was conducted in this area, and by the end of the summer, the infestation collapsed. No other infestations were detected in Montana in 1976 (Kohler 1977B).

1981.--After a lapse of 5 years', defoliation by the DFTM was again detected in Montana when an ornamental blue spruce was defoliated near Polson (Kohler 1981).
1982.--Ornamental blue spruce were defoliated in Polson, near Somers, and in the Rattlesnake area of Missoula. In June, seven locations that had 25+ male moths/pheromone trap in 1981 were sampled for early instar larvae. Larvae were found at four of the plots, but only at such numbers to classify the population level as "low" (Dewey et al. 1983).

1983.--No visible defoliation occurred in forested areas, but defoliation was observed on a few yard trees in Missoula, Polson, Somers, and near Clearwater Junction in the Blackfoot drainage east of Missoula. Spring surveys were made to determine early instar larval populations in eight areas that had high 1982 moth catches in pheromone traps. In general, few larvae were found in these plots. A plot near Somers was classified as suboutbreak; two plots near Frenchtown were rated between suboutbreak and low; and the remaining plots were classified as low-level populations (Tunnock et al. 1984; Dewey et al. 1985).

1984.--The only DFTM defoliation detected in western Montana was on a yard tree in Missoula and on a small group of Douglas-fir in a backyard near Somers. Eight plots that had more than 25 male moths per pheromone trap in 1983 were sampled in June of 1984 for early instars. Larval populations were classified as intermediate level at Kerr Dam and Somers #1 and low level at Somers #2, Frenchtown T and J, Corral Creek, Butler Creek, and Albert Creek (Dewey et al. 1985).

OTHER COLLECTION RECORDS

U.S. National Museum (USNM)

Nevada - DFTM first identified in the United States from specimens collected from subalpine fir at Jarbidge, Nevada in 1927.

Idaho - Specimens were forwarded to USNM on October 24, 1927 from collection made just outside Craters of the Moon National Monument.

Specimens were collected from Douglas-fir on the Sawtooth National Forest near Hailey, Idaho in August 1936 and forwarded to USNM.

Montana - USNM received a letter from Charles Faunce, Deputy Supervisor, Flathead Indian Reservation, dated August 3, 1923, which stated a Hemerocampa species believed to be DFTM was feeding on Douglas-fir. Unfortunately, no specimens were sent to the USNM, and identification cannot be substantiated.

Utah - No record.

Wyoming - No record.

SUPPRESSION EFFORTS

No attempt was made to suppress the DFTM with insecticides until 1947. That year, DDT was aerially applied in an operational project. Since then, ground and aerial applications have been used for experimental and operational purposes (appendix table 2).

Idaho

1947.--A recorded 395,535 acres (160,073 hectares) of grand fir and Douglas-fir forests were sprayed by fixed-wing aircraft in Clearwater, Latah, and Benewah Counties. This was the largest forest aerial spray project ever undertaken in the United States to that time. Infested areas were treated with DDT at the rate of 1 pound (0.45 kg) of technical DDT in 1 gallon (3.79 liters) fuel oil per acre. Spraying began on May 22 and terminated on July 2. No living larvae were found anywhere in the treated areas. Success was attributed to spraying during the first three larval stages when they were most susceptible. Workers estimated that spraying prevented the almost certain defoliation of host trees containing 1.5 billion board feet (8.5 million cubic meters) of merchantable sawtimber valued at $4,320,000. In addition, 140,000 acres (56,658 hectares) almost completely defoliated in 1946 were saved from being killed by additional defoliation in 1947 (Evenden and Jost 1947).

1961.--Heavily defoliated ornamental Douglas-fir, grand fir, and spruce trees were sprayed with a variety of insecticides from the ground in Moscow and in and near Bonners Ferry during the summer of 1961 (Tunnock 1962).

1963.--Infested ornamental Douglas-fir and grand fir around homes and groups of grand fir in farm woodlots were sprayed from the ground by the State of Idaho and private firms. The insecticide malathion was mainly used and gave poor control. Treated trees were located in Copeland, Algoma Lake, Albeni Falls, Hayden Lake, Coeur d'Alene, and around Bonners Ferry (Tunnock 1963B).

An aerial application of nucleopolyhedrosis virus (NPV) was applied to 12,575 acres (5,089 hectares) of forested land on the Boise National Forest in 1963. Six areas were treated in the Middle Fork of the Boise River drainage. The application appeared to have effectively reduced populations in sprayed areas (Anonymous 1963). Examination in 1964 of both sprayed and unsprayed infested areas showed the population had collapsed except for a 400-acre (162-hectare) area east of the sprayed sites. Collapse was attributed to virus and egg parasites (Anonymous 1964).

1965.--Epidemic populations developed again in the grand fir and Douglas-fir forests in Benewah and Latah Counties. Helicopters and fixed-wing aircraft sprayed about 120,000 acres (48,564 hectares) with DDT at the rate of three-fourths pound (0.34 kg) of technical DDT in 1 gallon (3.79 liters) diesel oil per acre. Spraying began on June 16 and ended on June 24. Blocks were released for spraying when 70 percent of the larvae were in the second instar. Some egg masses began hatching June 1.

Six days after spraying, no living larvae were found on sample trees along mortality lines in spray blocks. The average project cost to treat an acre was $1.11 (Scribner 1965).

In addition to the DDT operational spray project in June, a pilot test of nucleopolyhedrosis virus was made just northeast of Moscow near Moscow Mountain. The virus was obtained from cadavers of DFTM larvae infected in the field and in the laboratory. A helicopter sprayed 1,220 acres (494 hectares) at the rate of 1 billion polyhedra in 1 gallon (3.79 liters) of water per acre when most larvae were second instars.

Mortality from NPV was higher in an untreated area than in a treated area. From a July 29 larval collection, 80.5 percent died from virus in the check and 73.6 percent died in the treatment. Therefore, the application of 1 billion polyhedra per acre apparently did not have any significant effect on DFTM moth populations (Tunnock 1966).

1973.--In June, the insecticide Sevin 4-Oil^{R} (carbaryl) was field tested against DFTM larvae. It was sprayed from a helicopter on three 60-acre plots north of Potlatch in Benewah and Latah Counties. Application rate was 1 pound active ingredient (AI)/0.5 gallon (0.45 kg AI/1.90 liters) of oil carrier/acre. Average population reduction was 72.5 percent 16 days after treatment. Significant amounts of foliage were saved when spray blocks were compared to untreated check blocks (Livingston 1973).

1974.--Benewah and Latah Counties were infested for the third time since 1947 with epidemic populations. Helicopters applied DDT at the rate of three-fourths pound AI/gal (0.34 kg/3.79 liters) of oil carrier/acre to 75,254 acres (30,455 hectares) from June 19 to July 8. Spray blocks were released for treatment after 70 percent of the egg masses had hatched. Corrected larval mortality averaged 97.8 percent 4 days after spraying and 99.8 percent after 21 days. There was approximately 20 percent more defoliation in untreated areas than in treated areas 21 days after spraying. No egg masses were found in treated areas that fall. Project costs on a per-acre basis were $5.79 (Almas et al. 1975).

During the operational program, a pilot test of Sevin 4-Oil^{R} was set up ca. 10 miles east of Potlatch in Latah County. On July 11, two blocks, ca. 700 acres (280 hectares) each, were sprayed by helicopter. Sevin 4-Oil^{R} was applied at the rate of 1 lb AI/0.75 gal (0.68 kg AI/2.84 liters) of No. 2 fuel oil/acre. Most larvae were in the third and fourth instars. Larval populations were

reduced by the treatment 83 and 88 percent after 7 days, and 97 and 96 percent after 14 days. Mortality in the untreated check block was 10 and 58 percent after 7 and 14 days, respectively. Treatment gave some measurable foliage protection. A few egg masses were found in the fall in both treated and untreated areas (Ciesla et al. 1976).

Three commercial preparations of Bacillus thuringiensis Berliner were field tested on 20-acre (8.1-hectare) study plots replicated three times for each treatment east of Coeur d'Alene. Thuricide® 16B, Dipel® L.C., and Dipel® W.P. in 25 percent molasses were applied at a constant dosage of 8 billion International Units/acre. Application was made by helicopter on June 27-30 when 80 percent of the larvae were second instars. All treatments showed significantly ($P < .05$) greater population reductions than did the untreated control at 2, 7, and 21 days after treatment. No statistically significant differences were found at 35 days. The 35-day reductions were 75 percent for the control, 90 percent for Thuricide® 16B, 88 percent for Dipel® L.C., and 82 percent for Dipel® W.P. in molasses. None of these treatments clearly demonstrated superior foliage protection qualities (Stelzer and Neisess 1974).

A 1,200-acre (486-hectare) block of Sawtooth National Forest, public domain, State, and private land was treated with an aerial application of DDT in 1974. A dosage rate of 0.75 pound (0.34 kg) of DDT in 1 gallon (3.79 liters) of solvent and fuel oil per acre was used. Tussock moth larval populations were reduced below prespray levels and some foliage was saved (Graham et al. 1975).

1975.--Infested ornamental fir and spruce around private homes in the city of Coeur d'Alene were sprayed from the ground when larvae first began to appear on lower branches. Two formulations of carbaryl were used--Sevimol® at 4 pounds (1.8 kg) carbaryl in 1 gallon (3.79 liters) molasses, and Sevin Sprayable® (80 percent wettable powder). Postspray larval counts were not made, but that fall no current egg masses could be found on treated trees (Livingston 1975).

Montana

1974.--Sevin 4-Oil® was pilot tested on two infested areas of Douglas-fir of ca. 400 acres (162 hectares) each west of Frenchtown. Sevin 4-Oil® was applied at the rate of 1 lb. AI/0.75 gal. (0.91 kg AI/2.84 liters) of No. 2 fuel oil/acre by helicopter on June 14 and 15. Populations were reduced by 91 and 99 percent after 7 days and 96 and 99 percent after 14 days in the treated blocks. Mortality in the untreated check block was 26 and 51 percent after 7 and 14 days, respectively. Treatment gave some measurable foliage protection. That fall, virtually no new egg masses were found in treated areas, but 0.06/1,000 $in.^2$ foliage were found in the check area (Ciesla et al. 1976).

1976.--Infested Douglas-fir trees near St. Ignatius were sprayed from the ground with four insecticides on June 25. Those insecticides were Sevin® 50W, Orthene® 75S, Pyrocide® Growers Spray 7083, and Dimilin® W-25. A group of five trees was treated with each insecticide and spray was applied until it dripped off foliage. Only first and second instar larvae were present. One

hundred percent mortality occurred 14 days after treatment with all materials. Population reduction was 25 percent on untreated check trees 14 days after treatment (Kohler 1977B).

Nevada

1960.--An outbreak at Wheeler Peak, Nevada, was treated with a nucleopolyhedrosis virus in 1960. The infestation occupied 5,000 acres (2,000 hectares) in 1959 and approximately 4,400 acres (1,760 hectares) were treated in 1960. Three concentrations of virus were used: 1.25×10^8, 5.00×10^8, and 10.00×10^8 polyhedra per ml. per gallon (3.79 liters) applied at 1 gallon (3.79 liters) per acre. The formulation included corn syrup, nonchlorinated water, and a tracer, Leucophor C. Spray was applied with a Stearman aircraft. Tussock moth mortality ranged from 59 to 71 percent (Washburn et al. 1960).

SURVEYS USING PHEROMONE-BAITED STICKY TRAPS

Pheromone-baited sticky traps were used to detect the presence of DFTM at numerous locations in the Intermountain and Northern Rocky Mountain Regions from 1975 through 1984. Trapped male moths were identified and counted. Appendix table 3 shows the total number of plots (5 traps/plot) and total number of male moths captured from 1980 to 1984.

Nevada

1975.--Male moths were caught on the Jarbidge and Ely Ranger Districts, Humboldt National Forest; Las Vegas Ranger District, Toiyabe National Forest; and Virgin Peak, on public domain lands administered by BLM (Ollieu 1978).

Utah

1976.--Sticky traps caught male moths on the Manti-LaSal, Uinta, and Wasatch National Forests. This is the first record of DFTM in Utah (Ollieu 1978).

1977.--Male moths were caught in 1977 on the Fishlake, Manti-LaSal, Uinta, and Wasatch National Forests (Ollieu 1978).

Idaho

1975.--Traps caught male moths in the Owyhee Mountains, Boise National Forest and Sawtooth National Forest in southern Idaho (Ollieu 1978). In northern Idaho, traps were placed at 312 sites throughout most of the host range from the Canadian border south to the Seven Devils Mountains area near Riggins. Male moths were caught at 239 of the sites (Livingston 1976A).

1976.--In southern Idaho, male moths were trapped on the Boise, Challis, Payette, Sawtooth, and Targhee National Forests (Ollieu 1978). In northern Idaho, the survey was expanded into areas not covered in 1975, mainly on National Forest lands north of the Salmon River to the St. Joe River. Males were caught throughout this region (Livingston 1976B).

1977.--Trapping was continued in 1977, and males were caught on the Challis, Salmon, Sawtooth, and Targhee National Forests in southern Idaho (Ollieu 1978).

Traps placed in 10 areas from the Coeur d'Alene Mountains to the Clearwater Mountains southeast of Kooskia produced male moths (Livingston et al. 1978).

1978.--Pheromone traps were placed on 12 sites previously infested by tussock moths. Only one male moth was caught from the 12 locations (at Peterson Point) (Robinson et al. 1979).

1979.--Pheromone traps were placed on the same 12 locations sampled during 1978. A total of only 18 male moths were caught. They were trapped at Coeur d'Alene Mountain, Lolo Pass, Charles Butte, Flat Creek, Long Creek, Mineral Mountain, and Mission Mountain (Livingston et al. 1980).

1980.--Pheromone-baited sticky traps were placed at 22 known locations of previous DFTM outbreaks. Catches of adult moths at Dewey Peak in the Owyhee Mountains indicated significant population expansion. Elsewhere no male moths were collected (Knopf 1980, Livingston et al. 1981).

1981.--Pheromone-baited traps were placed at all known locations of previous DFTM outbreaks and in some potential areas. A total of 82 plots were sampled. Male moths were trapped on 51 of the plots. Number of moths from five traps ranged from 0 at one plot to 64 at Dewey Peak in the Owyhee Mountains (Dewey et al. 1983; Thier 1982).

1982.--Adult moth trapping was intensified and expanded into additional areas from 1981 because the probability of an outbreak was becoming more imminent. The number of plots increased from 82 in 1981 to 144 in 1982. Male moths were caught in 120 of the 1982 plots. Trap catches were higher in 1982 and the greatest increases occurred in Idaho north of Moscow.

Several plots had catches higher than 25 moths per trap. They were near Orofino at Johnson's Mill and Long Creek, and on the Payette National Forest at Adam's Creek, Fourbit Creek, Olive Creek, and East Fork Brownlee Creek which had the highest catch of 61.2 moths per trap (Dewey et al. 1983; Thier 1983).

1983.--There was an increasing trend in the number of male moths caught in pheromone traps. In 1983, 151 plots were sampled and the greatest increase occurred in the Plummer-Moscow zone. Historically, this area has sustained the highest DFTM populations. Widespread increases in the number of moths trapped were noted on the Boise, Salmon, and Sawtooth National Forests (Dewey et al. 1985, Thier and Mocettini 1984).

1984.--In northern Idaho, moth catches increased at 45 of the 62 plots surveyed in 1983 north of Moscow, but remained at very low levels south of Moscow. The Mineral Mountain plot in the Moscow to Plummer area contained 59 moths per trap, and egg masses were found in the forest in this zone. Some visible defoliation may occur there in 1985. Past outbreaks usually have started in this part of

the Palouse country (Dewey et al. 1985). In southern Idaho, the increasing trend in the number of male moths caught in pheromone traps in 1983 was broadly reversed in 1984. A total of 27 plots were sampled. Male moths were trapped on 21 of the plots. The average number of moths per trap ranged from 0 on six plots, to 18.0 at Stacy Creek on the Payette National Forest. None of the plot catches indicate future defoliation (Thier 1984 unpublished data).

Montana

1975.--Phermone-baited traps were placed at 95 locations in western Montana and 30 locations east of the Continental Divide. Male moths were caught at 69 locations in western Montana and none east of the Divide. Distribution was concentrated along the Flathead Valley, Swan Valley, Clark Fork drainage west and east of Missoula, Blackfoot River drainage east of Missoula to Greenough, and Bitterroot Valley south to Darby (Kohler 1976B).

1976.--Traps with stronger baits were placed at 43 locations, mostly east of the Continental Divide. Males were caught in six of the areas west of the Divide and in two areas east of the Divide; these were in the Wolf Creek drainage north of Helena (Kohler 1977A).

1977.--Eight survey plots were established in the Missoula and Flathead Valleys. They were sampled for tussock moth larvae and male moths. No larvae were detected, but moths were caught in pheromone traps at all plots (Kohler 1978).

1978.--Male moths were caught in phermone traps at six of nine plots established in areas of previous outbreaks (Robinson et al. 1979).

1979.--Sixteen locations were sampled for male moths using pheromone traps. Numbers per trap were low and in the endemic range (Dewey and Dooling 1980).

1980.--Only 10 male moths were caught in pheromone traps placed at eight locations in western Montana. The three areas that had moths were Corral Creek, Church Farm, and Frenchtown (Kohler 1980).

1981.--Pheromone traps were placed in 12 locations and male moths were caught at 11 of them. Average moths per trap ranged from 3.0 at Big Arm to 77.8 in Frenchtown (Kohler 1981).

1982.--Pheromone traps were placed in a few more locations during 1982 in western Montana. Male moths were caught in 14 out of 15 plots and catches increased in 11 locations. As in 1981, the highest moth count was in the Frenchtown area where an average of 78.4 moths/trap was recorded (Dewey et al. 1983).

1983.--Pheromone-baited trapping was increased from 15 locations in 1982 to 33 in 1983. Only eight of the 33 areas had catches exceeding 25 moths/trap compared to 10 of 15 areas in 1982. High catches were made at Albert Creek, Corral Creek, near Frenchtown, in Ninemile Creek, at Kerr Dam, and at Somers (Dewey et al. 1985).

1984.--Moth catches declined quite substantially on most of the 33 plots in western Montana. Average number of moths per trap ranged from 0 at Hellroaring Creek near Polson, to 76.6 at Pistol Creek near St. Ignatius. Out of eight plots that had more than 25 moths per trap in 1983, only two traps had more than 25 moths in 1984 (Dewey et al. 1985).

REFERENCES CITED

Almas, D., W. Bousfield, L. Livingston, and W. Ludeman.
1975. 1974 North Idaho cooperative Douglas-fir tussock moth control project report. State of Idaho Department of Lands, Coeur d'Alene, Idaho. Report No. 75-1, 60 p., illus., maps.

Anonymous.
1929. Map of Boise National Forest showing insect damage in 1929. Filed at USDA Forest Service, Forest Pest Management, Boise, Idaho.

Anonymous.
1956. Summary of insect conditions, Northern Rocky Mountains, 1956. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 3 p.

Anonymous.
1957. Forest insect conditions in the Intermountain and Northern Rocky Mountain States during 1956. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 5 p.

Anonymous.
1958. Forest insect conditions in the Intermountain and Northern Rocky Mountain States during 1957. USDA Forest Service, Intermountain Forest and Range Exp. Sta. Publication No. 13, 11 p.

Anonymous.
1960. Forest insect conditions in the Intermountain and Northern Rocky Mountain States during 1959. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Misc. Publication No. 23, 12 p.

Anonymous.
1963. Defoliator infestations, Forest Service, Region 4. USDA Forest Service, Branch Forest Insect and Disease Prevention and Control, Ogden, Utah, 14 p., maps.

Anonymous.
1964. Defoliator infestations, Forest Service, Region 4. USDA Forest Service, Branch Forest Insect and Disease Prevention and Control, Ogden, Utah, 17 p., 1 map.

Anonymous.
1974A. Environmental statement, cooperative Douglas-fir tussock moth, pest management plan. USDA Forest Service, Pacific Northwest Region, Portland, Oregon, 301 p, maps.

Anonymous.
1974B. Status of forest insect and disease conditions and programs in Intermountain Region 1974. USDA Forest Service, Region 4, Ogden, Utah, 10 p., 1 map.

Anonymous.
1981. Forest insect and disease conditions Intermountain Region, 1981. USDA Forest Service, Region 4, Ogden, Utah, 24 p.

Anonymous.
1982. Forest insect and disease conditions in Idaho - 1981. Idaho Dept. of Lands; USDA Forest Service, Insect and Disease Control, Coeur d'Alene, Idaho.

Balch, R. E.
1930. The fir tussock moth (observations in 1929). Forest Insect Field Station, Coeur d'Alene, Idaho. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 19 p., illus.

Bousfield, W. E. and J. D. Ward.
1976. Observations of impact on the Nezperce National Forest caused by the Douglas-fir tussock moth. USDA Forest Service, State and Private Forestry, Missoula, Montana, I&D Report No. 76-9, 5 p., map.

Ciesla, W. M., S. Kohler, J. E. Dewey, and M. D. McGregor.
1976. Field efficacy of aerial applications of carbaryl against Douglas-fir tussock moth. J. Econ. Entomol., 69 (21):219-224, graphs.

Cole, W. E.
1958. Douglas-fir tussock moth situation in Owyhee County, Idaho. 1958. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 4 p.

Dewey, J. E., and O. J. Dooling.
1980. Forest insect and disease conditions in the Northern Region - 1979. USDA Forest Service, Forest Insect and Disease Management, Missoula, Montana. Report R1-80-7, 17 p., maps.

Dewey, J. E., R. L. Livingston, and S. Kohler.
1983. Douglas-fir tussock moth adult male survey north Idaho and western Montana, 1982. USDA Forest Service, Cooperative Forestry & Pest Management, Missoula, Montana. Report 83-14, 11 p.

Dewey, J. E., R. L. Livingston, and S. Kohler.
1985. Douglas-fir tussock moth population surveys - north Idaho and western Montana 1983 and 1984. USDA Forest Service, Cooperative Forestry & Pest Management, Missoula, Montana, Report 85-10, 20 p.

Dodge, H. R.
1956. Instructions for the control of the tussock moth in northeastern Washington in 1956. USDA Forest Service, Forest Insect Lab., Missoula, Montana. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 4 p., illus.

Eaton, C. B., and G. R. Struble.
1957. The Douglas-fir tussock moth in California. Pan-Pacific Ent. 33: 105-108.

Evenden, J. C.
1932. Letter of December 22 to C. L. Forsling, Director Intermountain Forest and Range Exp. Sta. File Project E-3. Filed at USDA Forest Service, Forest Pest Management, Boise, Idaho.

Evenden, J. C., and E. J. Jost.
1946. Report on an outbreak of the Douglas-fir tussock moth (Hemerocampa pseudotsugata) in Latah and Clearwater Counties, Idaho. USDA, Bureau of Entomology and Plant Quar., Forest Insect Lab., Coeur d'alene, Idaho. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 22 p., illus., map.

Evenden, J. C., and E. J. Jost.
1947. A report of the tussock moth control, North Idaho, 1947. USDA Bureau of Entomology and Plant Quar. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 28 p., illus., maps.

Farrel, J. W.
1938. Memorandum to J. A. Beal, Forest Insect Laboratory, Fort Collins, Colorado. File control, September 8, 1938. Filed at USDA Forest Service, Forest Pest Management, Boise, Idaho.

Ferguson, D.C.
1978. The moths of America north of Mexico. Fascicle 22.2. Noctuoidea: Lymantriidae. E. W. Classey Limited and the Wedge Ent. Res. Found. 110 p illus.

Gibson, K. E., R. L. James, R. L. Livingston, J. W. Schwandt, D. P. Beckman, R. W. Thier, J. P. Marshall, and K. A. Knapp.
1984. Idaho forest pest conditions and program summary - 1983. USDA Forest Service, Northern and Intermountain Regions; Idaho Dept. of Lands, Coeur d'Alene, Idaho. Report No. 84-1, 40 p., illus.

Graham, D. A., J. Mounts, and D. Almas.
1975. 1974 Cooperative Douglas-fir tussock moth control project. USDA Forest Service, Pacific Northwest Region, Portland, Oreogn.

Hamel, D. R., and O. J. Dooling.
1975. USDA Forest Service, State and Private Forestry, Missoula, Montana. Report No. 75-1, 26 p., illus., maps.

Helzner, R. and M. Moyer.
1978. Forest insect and disease conditions Intermountain Region 1978. USDA Forest Service, Region 4, Ogden, Utah, 19 p, 1 map.

Haycock, T. C.
1938. Memorandum to J. A. Beal, Entomologist, Forest Insect Investigations, Fort Collins, Colorado. File S-Control September 17, 1938. Filed at USDA Forest Service, Forest Pest Management, Boise, Idaho.

Johnson, P. C.
1949. Natural decline of tussock moth infestations in the Inland Empire. USDA Bureau of Entomology and Plant. Quar., Forest Insect Lab., Coeur d'Alene, Idaho. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 6 p.

Klein, W. H., and M. D. McGregor.
1966. Forest insect conditions in the Intermountain States during 1965. USDA Forest Service, Region 4, Ogden, Utah, 13 p., 1 map.

Klein, W. H.
1967. Forest insect conditions in the Intermountain States during 1966. USDA Forest Service, Region 4, Ogden, Utah, 17 p., 1 map.

Knapp, K. W.
1985. Forest insect and disease conditions Intermountain Region 1984. USDA Forest Service, Region 4, Ogden, Utah.

Knopf, J. A. E.
1961. The status of defoliator infestations in Region 4. USDA Forest Service, Branch of Forest Insect and Disease Prevention and Control, Ogden, Utah, 10 p., 3 maps.

Knopf, J. A. E.
1973. Biological evaluation, Douglas-fir tussock moth, south central Idaho, 1973. USDA Forest Service, Branch Insect and Disease Prevention and Control, Region 4, Ogden, Utah, 5 p., 1 map.

Knopf, J. A. E.
1980. Forest insect and disease conditions Intermountain Region 1980. USDA Forest Service, Region 4, Ogden, Utah, 14 p., 1 map.

Kohler, S.
1976A. Forest insect conditions in Montana, 1975. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana. Insect and Disease Report. Report 76-1, 5 p.

Kohler, S.
1976B. Douglas-fir tussock moth detection survey using pheromone-baited sticky traps. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana. Insect and Disease Report 76-2, 6 p., maps.

Kohler S.
1977A. Douglas-fir tussock moth detection survey using pheromone-baited sticky traps - 1976. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana. Insect and Disease Report 77-2, 7 p., maps.

Kohler, S.
1977B. Ground application of four insecticides on Douglas-fir tussock moth and western spruce budworm populations in Montana. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana. Insect and Disease Report 77-1, 8 p.

Kohler, S.
1978. Forest insect and disease conditions in Montana - 1977. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana. Insect and Disease Report 78-2, 7 p., maps.

Kohler, S.
1980. Field data sheet. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana.

Kohler, S.
1981. Field data sheet. Montana Department of Natural Resources and Conservation, Div. of Forestry, Missoula, Montana.

Livingston, R. L.
1973. Douglas-fir tussock moth field experiment, preliminary results. Idaho Department of Public Lands, Coeur d'Alene, Idaho. Memorandum dated August 6, 1973, 2 p. Filed at USDA Forest Service, State and Private Forestry, Missoula, Montana.

Livingston, R. L.
1975. Treatment of Douglas-fir tussock moth in urban Coeur d'Alene with Sevin Sprayable® and Sevimol® insecticides. State of Idaho Department of Lands, Coeur d'Alene, Idaho, Report 75-3, 2 p.

Livingston, R. L.
1976A. Use of sex attractants as a survey tool to determine geographic distribution of the Douglas-fir tussock moth, Orgyia pseudotsugata, McD. (Lepidoptera: Lymantriidae) in north Idaho: 1975. State of Idaho, Department of Lands, Coeur d'Alene, Idaho, Report 76-2, 5 p., maps.

Livingston, R. L.
1976B. Field testing of synthetic pheromone for use in early warning survey trapping and population assessment of the Douglas-fir tussock moth, Orgyia pseudotsugata, McD. (Lepidoptera: Lymantriidae). Accomplishment Report, October 8, 1976 to DFTM Res. and Development Program, Portland, Oregon. State of Idaho, Department of Lands, Coeur d'Alene, Idaho, 3 p., map.

Livingston, R. L., J. Schwandt, and D. Beckman.
1978. Forest insect and disease conditions in Idaho - 1977. Idaho Department of Lands, Forest Insect and Disease Control, Coeur d'Alene, Idaho, Report 78-1, 24 p., maps.

Livingston, R. L., J. Schwandt, and D. Beckman.
1980. Forest insect and disease conditions in Idaho - 1978 and 1979. Idaho Department of Lands, Forest Insect and Disease Control, Coeur d'Alene, Idaho. Report 80-1, 27 p., maps.

Livingston, R. L., J. E. Dewey, and K. A. Knapp.
1981. Forest insect and disease conditions in Idaho. Idaho Department of Lands, Forest Insect and Disease Control, Coeur d'Alene, Idaho; USDA Forest Service, Missoula, Montana. Report 81-13, 22 p., maps.

Moyer, M.
1977. Forest insect and disease conditions, Intermountain Region - 1976. USDA Forest Service, State and Private Forestry, Ogden, Utah, 10 p., illus., map.

Ollieu, M.
1978. Detection of Douglas-fir tussock moth in the Intermountain Region using baited sticky traps. USDA Forest Service, Forest Insect and Disease Management, Boise, Idaho.

Orr, L.W.
1952. Forest insect conditions in the Intermountain Region in 1951. USDA Agricultural Research Administration, Bureau of Entomology Plant Quarantine, Ogden, Utah. Unpublished report filed at USDA Forest Service, Forest Pest Management, Boise, Idaho, 11 p.

Parker, D. L., L. E. Stipe, and A. C. Tegethoff.
1972. Forest insect and disease conditions in the Intermountain States 1971. USDA Forest Service, Region 4, Ogden, Utah, 10 p., 1 map.

Parker, D. L.
1973. Status of forest insect and disease conditions and programs in the Intermountain Region 1972. USDA Forest Service, Region 4, Ogden, Utah, 12 p., 1 map.

Robinson, L. A., J. E. Dewey, and C. E. Carlson.
1979. Forest insect and disease conditions in the Northern Region - 1978. USDA Forest Service, Forest Insect and Disease Management, Missoula, Montana. Report R1-79-17, 17 p., maps.

Scribner, W. A.
1965. Potlatch tussock moth control project, 1965. Unpublished report on file at Cooperative Forestry & Pest Management, Federal Building, Missoula, Montana, 29 p., illus., map.

Stelzer, J. M. and J. A. Neisess.
1974. Study No. 3--1974 field experiments with Bacillus thuringiensis to control Douglas-fir tussock moth in Idaho. Interim Report, Douglas-fir Tussock Moth Research and Development Program. USDA Forest Service, Pacific NW Forest and Range Exp. Sta., Portland, Oregon, 4 p., graphs.

Thier, R. W.
1982. Douglas-fir tussock moth monitoring in southern Idaho during 1981. USDA Forest Service, Region 4, Ogden, Utah, Report No. 82-6, 5 p.

Thier R. W.
1983. Douglas-fir tussock moth monitoring in southern Idaho during 1982. USDA Forest Service, Region 4, Ogden, Utah, Report No. 83-2, 8 p.

Thier, R. W. and J. Hoffman.
1982. Forest insect and disease conditions Intermountain Region 1982. USDA Forest Service, Region 4, Ogden, Utah, 23 p.

Thier, R. W., and P. J. Mocettini.
1984. Douglas-fir tussock moth monitoring in southern Idaho during 1983. USDA Forest Service, Region 4, Ogden, Utah, Report No. 84-2, 7 p., 13 maps.

Trostle, G. C.
1973. Biological evaluation, McFarland Canyon and Camp Bonanza Boy Scout Camp, Toiyabe National Forest and Virgin Peak, BLM Land, East of Mesquite. USDA Forest Service, Branch Forest Insect and Disease Prevention and Control, Ogden, Utah, 6 p.

Tunnock, S.
1962. Biological evalutions of three Douglas-fir tussock moth infestations in northern Idaho, 1961. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 5 p., illus., map.

Tunnock, S.
1963A. Trends of Douglas-fir tussock moth infestations in northern Idaho and Colbert, Washington, 1962. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 5 p., illus., map.

Tunnock, S.
1963B. Douglas-fir tussock moth infestations in northern Idaho and northwestern Montana, 1963. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 5 p., illus., map.

Tunnock, S.
1964. Status and trends of Douglas-fir tussock moth infestations in northern Idaho and northwestern Montana, 1964. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 10 p., illus.

Tunnock, S.
1965. Evaluation of Douglas-fir tussock moth infestations in northern Idaho and northwestern Montana, 1965. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 5 p., map.

Tunnock S.
1966. A pilot test to control Douglas-fir tussock moths by an aerial application of nuclear polyhedrosis virus during 1965. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, 17 p., illus., map.

Tunnock, S., and F. W. Honing.
1971. Detection survey for Douglas-fir tussock moth infestation in the Northern Region--1971. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana, Report 71-42, 3 p., map.

Tunnock, S.
1972. Detection survey for Douglas-fir tussock moth infestations in the Northern Region, 1972. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana. Report I-72-8, 1 p., map.

Tunnock, S.
1973. The Douglas-fir tussock moth in the Northern Region - A cartographic history of outbreaks from 1928 to 1973. USDA Forest Service, State and Private Forestry, Missoula, Montana. Report 73-27, 18 p., illus., maps.

Tunnock, S., J. E. Dewey, R. Lood, and R. L. Livingston.,
1973. Status of Douglas-fir tussock moth infestations in the Northern Region, 1973. USDA Forest Service, Div. of State and Private Forestry, Missoula, Montana. Report 73-23, 3 p., maps.

Tunnock, S., J. E. Dewey, S. Kohler, and S. Haglund.
1974. Evaluation of a Douglas-fir tussock moth outbreak in the lower Flathead Valley, Montana. USDA Forest Service, State and Private Forestry, Missoula, Montana. Report 74-24, 10 p.

Tunnnock, S. and O. J. Dooling.
1976. Forest insect and disease conditions, 1975. USDA Forest Service, State and Private Forestry, Missoula, Montana. Report 76-01, 14 p., maps.

Tunnock, S., M. D. McGregor, and R. D. Lood.
1976. Natural mortality in a Douglas-fir tussock moth infestation in northern Idaho, 1974. USDA Forest Service, State and Private Forestry, Missoula, Montana. Report 76-8, 9 p., map.

Tunnock, S., O. J. Dooling, and S. Kohler.
1984. Montana forest pest conditions and program highlights - 1983. USDA Forest Service, Cooperative Forestry & Pest Management, Montana Department of State Lands, Div. of Foresry, Forest Insect and Disease Section, Missoula, Montana. Report 84-2, 50 p., illus.

Valcarce, A. C.
1976. Forest insect conditions, Boise Zone, 1975. USDA Forest Service, Forest Insect and Disease Management, Boise, Idaho, 8 p.

Washburn, R. I.
1959. Status of forest insect conditions, Wheeler Peak Area, Humboldt National Forest. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 2 p.

Washburn, R. I., and W. E. Cole.
1960. The status of defoliator infestations in Forest Service, Region 4. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 13 p., maps.

Washburn, R. I., W. E. Cole, and D. B. Cahill.
1960. An experimental test for the use of virus against tussock moth in white fir. Pilot Control Test, Wheeler Peak Area, Humboldt National Forest 1960. USDA Forest Service, Intermountain Forest and Range Exp. Sta., Ogden, Utah, 12 p.

Washburn, R. I., and F. W. Honing.
1962. Defoliator infestations in Forest Service, Region 4. USDA Forest Service, Branch Forest Insect and Disease Prevention and Control, Ogden, Utah, 17 p., 3 maps.

Wickman, B. E., G. C. Trostle, and P. E. Buffam.
1971. Douglas-fir tussock moth. USDA Forest Service, Forest Pest Leaflet 86, 6 p., illus.

Wickman, B. E., R. Mason, and C. G. Thompson.
1973. Major outbreaks of the Douglas-fir tussock moth in Oregon and California. USDA Forest Service, Pacific NW Forest and Range Exp. Sta., Portland, Oregon, General Tech. Report PNW-5, 18 p.

Table 1.—Summary of outbreaks of Douglas-fir tussock moth in Nevada, Idaho, and Montana, 1927 through 1984.

	LOCATION OF OUTBREAKS (NATIONAL FOREST OR COUNTY)					
Year(s)	Nevada	(Reference page)	Idaho	(Reference page)	Montana	(Reference page)
1927	Humboldt NF	(p 2)				
1928–1929	Humboldt NF	(p 2)	Weiser & Boise NF	(p 3)		
1935–1939			Sawtooth NF	(p 3)		
1938	Humboldt NF	(p 2)	Sawtooth & Lemhi NF	(p 3)		
1944–1945			Kootenai, Latah & Bonner Co.	(p 3)		
1946–1947			Latah, Benewah & Clearwater Co.	(p 4)		
1949–1951			Owyhee Co.	(p 4)		
1955			Clearwater Co.	(p 4)		
1956			Benewah Co.	(p 4)	Lake Co.	(p 9)
1956–1959	Humboldt NF	(p 2)	Owyhee Co.	(p 4)		
1960	Lincoln Co. Humboldt NF	(p 2) (p 2)				
1961–1962	Humboldt NF	(p 2)	Latah, Boundary, Kootenai, & Benewah Co.	(p 5)		
			Boise NF	(p 5)		
1963	Humboldt NF	(p 2)	Latah, Bonner, Boundary, Kootenai & Benewah Co.	(p 5)	Flathead Co.	(p 9)
			Boise NF	(p 5)		
			Owyhee Co.	(p 5)		
1964			Boise NF	(p 6)	Flathead, Lake & Missoula Co.	(p 10)
1964–1965			Benewah, Latah & & Kootenai Co.	(p 5 & 6)		
			Owyhee Co.	(p 6)		
1965					Lake Co.	(p 10)

Year(s)	Nevada	(Reference page)	Idaho	(Reference page)	Montana	(Reference page)
1966			Owyhee Co.	(p 6)		
1970-1971			Owyhee Co.	(p 6 & 7)	Lake & Missoula Co.	(p 10)
1971	Toiyabe NF	(p 3)	Kootenai Co.	(p 7)		
1972	Clark Co.	(p 3)	Owyhee Co.	(p 7)		
			Kootenai & Benewah Co.	(p 7)		
1973-1974	Toiyabe NF	(p 3)	Benewah & Latah Co.	(p 7)	Missoula & Lake Co.	(p 10)
			Sawtooth NF	(p 7 & 8)		
			Clearwater NF	(p 7 & 8)		
			Coeur d'Alene NF	(p 7 & 8)		
			Nezperce NF	(p 7 & 8)		
1975			Kootenai Co.	(p 8)	Missoula & Lake Co.	(p 10)
			Cassia Co.	(p 8)		
1976			Owyhee Co.	(p 8)	Lake Co.	(p 11)
1978			Ada Co.	(p 8)		
1980			Idaho Co.	(p 8)		
1981			Kootenai, Owyhee & Blaine Co.		Lake Co.	(p 11)
			Clearwater NF	(p 8)		
1982			Kootenai, Benewah Nezperce, Lewis Idaho, Ada, Blaine, Lincoln, Gooding, & Owyhee Co.	(p 9)	Lake, Flathead & Missoula Co.	(p 11)
1983			Kootenai, Latah Nezperce, Lewis & Owyhee Co.	(p 9)	Lake, Flathead, & Missoula Co.	(p 11)
1984			Kootenai & Latah Co.	(p 9)	Flathead & Missoula Co.	(p 11)

Table 2.--Forest lands aerially sprayed with insecticide to suppress Douglas-fir tussock moth in Idaho, Nevada, and Montana, 1947 through 1974.

Year	Forest or county	Type of treatment	Insecticide used Toxicant:	Toxicant/acre	Acreage treated
			IDAHO		
1947	Benewah, Clearwater & Latah Co.	Operational	DDT	1.0 lb	395,535
1963	Boise NF	Operational	NPV[1]	8.25×10^{12} p[2]	12,575
1965	Benewah & Latah Co.	Operational	DDT	0.75 lb	120,000
	Latah Co.	Experimental	NPV	1 Billion P	1,220
1973	Benewah & Latah Co.	Experimental	Carbaryl	1.0 lb.	180
1974	Benewah & Latah Co.	Operational	DDT	0.75 lb.	75,254
	Sawtooth NF	Operational	DDT	0.75 lb.	1,200
	Coeur d'Alene NF	Experimental	B.t.[3]	8 Billion IU[4]	180
	Latah Co.	Experimental	Carbaryl	2.0 lb.	1,400
			NEVADA		
1960	Humboldt NF	Experimental	NPV	1.25×10^8 P 5.00×10^8 P 10.00×10^8 P	4,400
			MONTANA		
1974	Missoula Co.	Experimental	Carbaryl	2.0 lb.	400

[1] NPV = nucleopolyhedrosis virus.
[2] P = polyhedra (contain virus rods).
[3] B.t. = a species of bacteria, Bacillus thuringiensis.
[4] IU = International Units per acre.

Table 3.--Number of pheromone trap plots and total number of male moths captured on all the plots from 1980-1984 in Montana and Idaho.[1]

Location	1980	1981	1982	1983	1984
	Total number plots/Total number moths				
W. Montana	8/10	12/1192	15/2557	33/2940	33/1248
Idaho, N. of Moscow	20/0	39/122	46/856	62/1585	63/2757
Idaho, S. of Moscow	11/3	34/415	71/1017	60/166	60/67
Idaho S. of Salmon R.	0/0	7/128	19/1375	24/3439	26/546
TOTALS	39/13	92/1857	151/5805	179/8130	182/4618

[1] Data from Dewey et al. 1985; and Knapp 1985

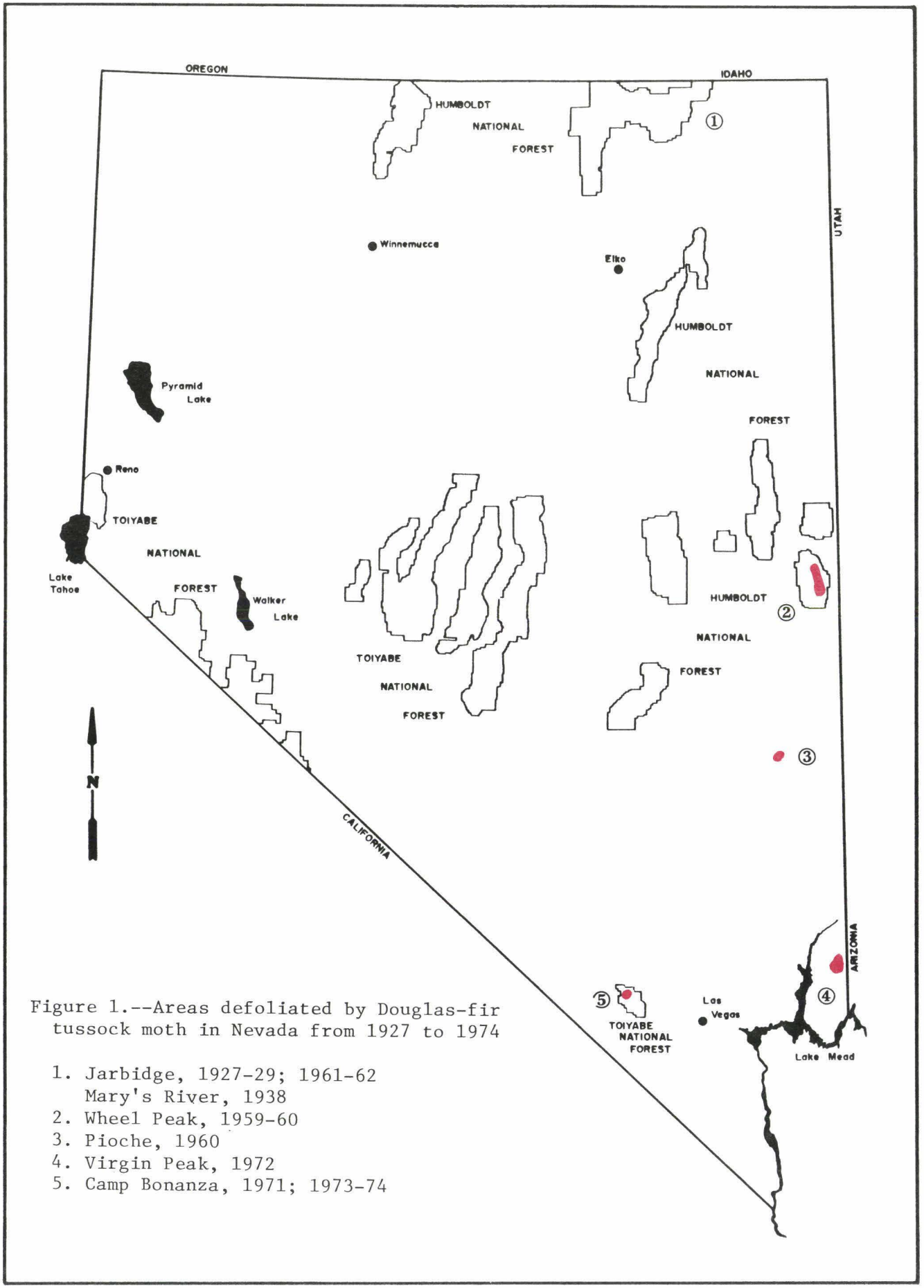

Figure 1.--Areas defoliated by Douglas-fir tussock moth in Nevada from 1927 to 1974

1. Jarbidge, 1927-29; 1961-62
   Mary's River, 1938
2. Wheel Peak, 1959-60
3. Pioche, 1960
4. Virgin Peak, 1972
5. Camp Bonanza, 1971; 1973-74

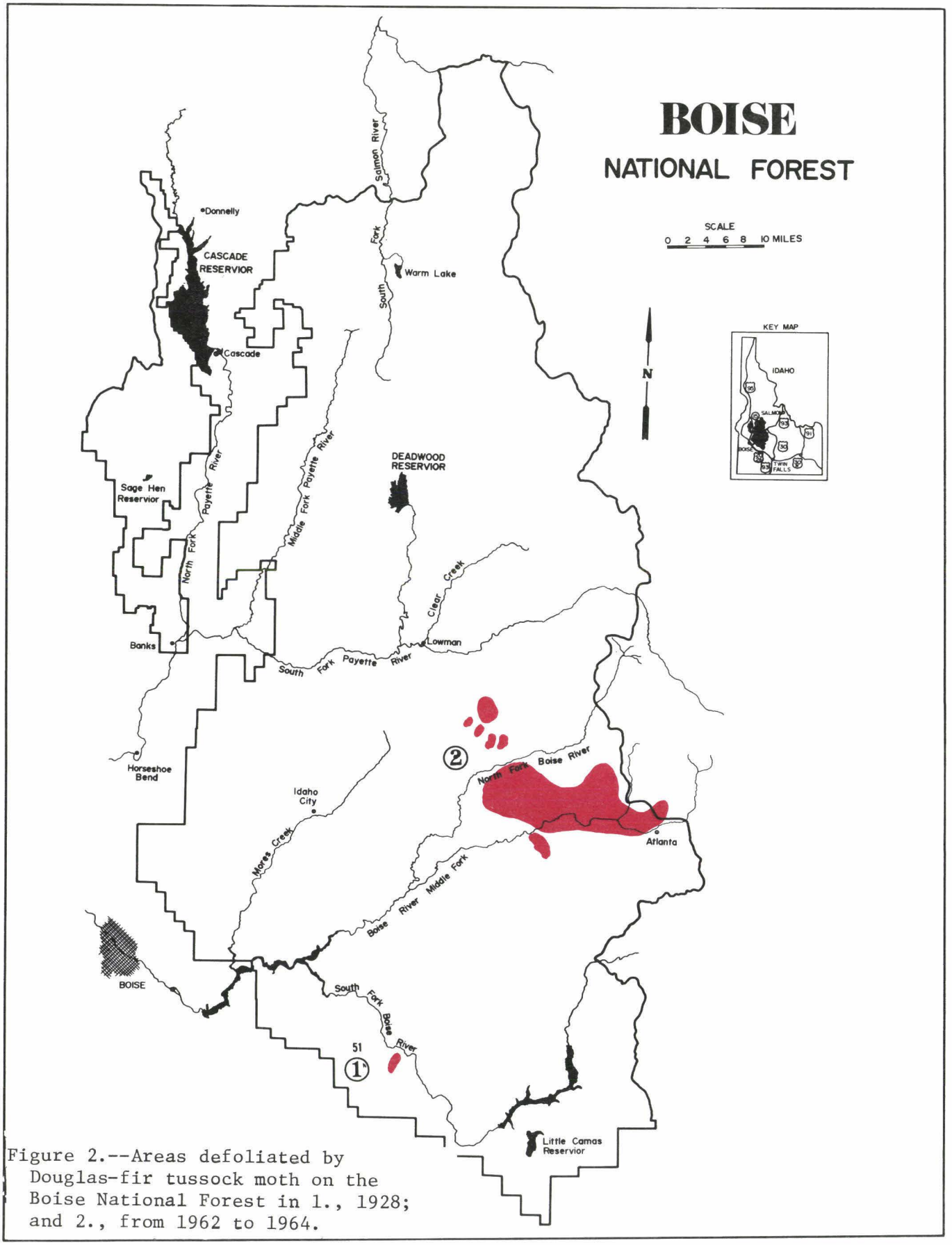

Figure 2.--Areas defoliated by Douglas-fir tussock moth on the Boise National Forest in 1., 1928; and 2., from 1962 to 1964.

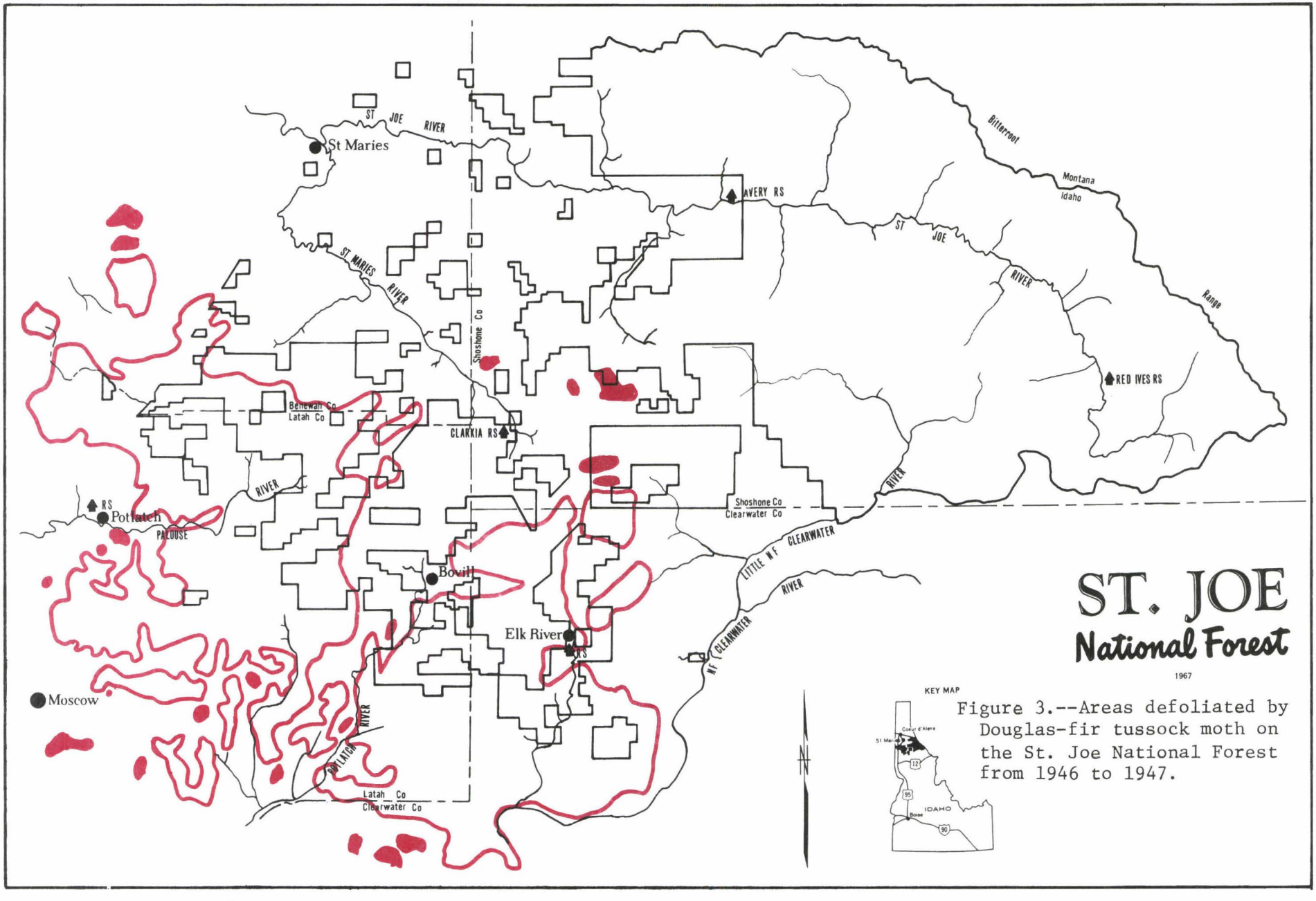

Figure 3.--Areas defoliated by Douglas-fir tussock moth on the St. Joe National Forest from 1946 to 1947.

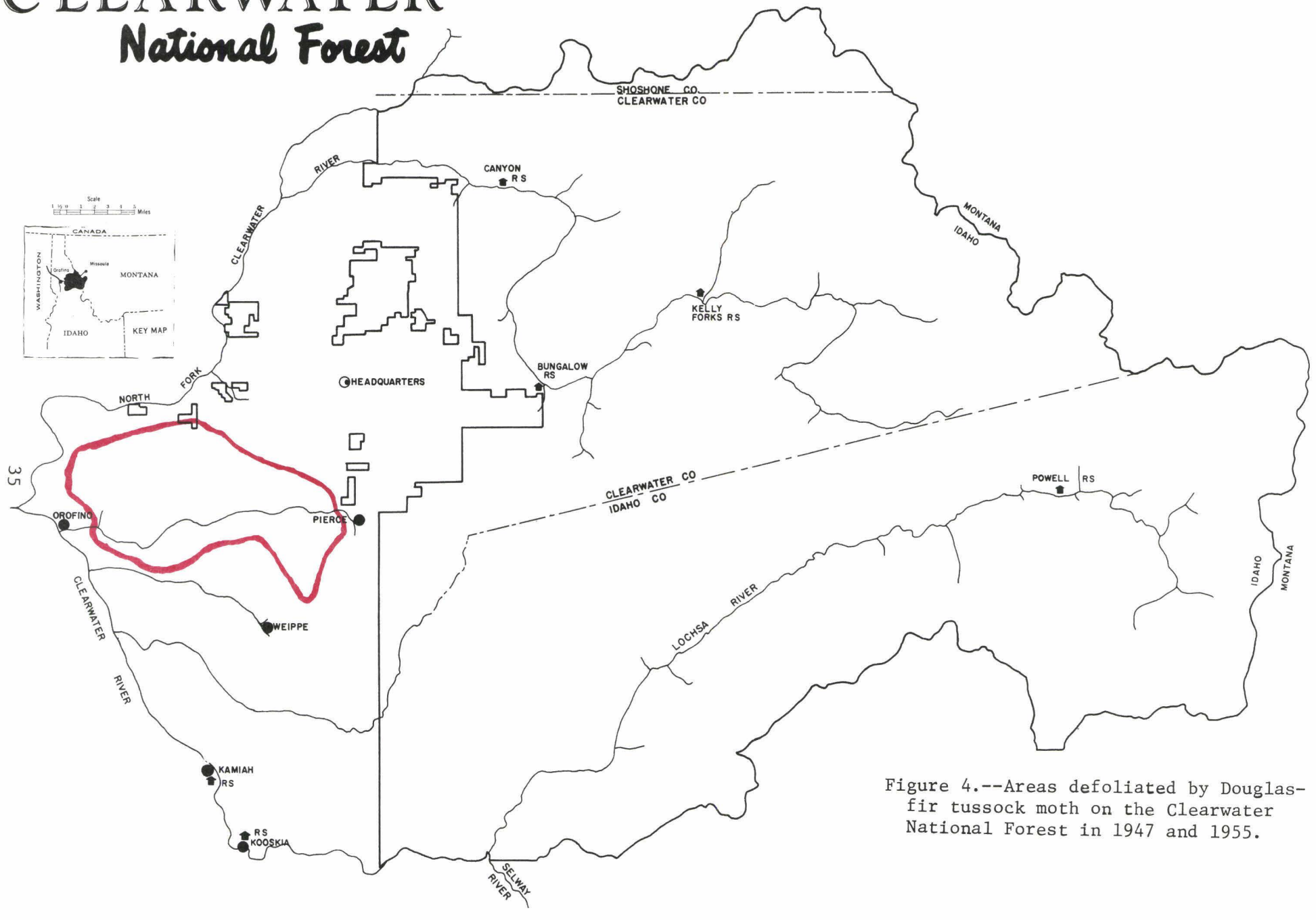

Figure 4.--Areas defoliated by Douglas-fir tussock moth on the Clearwater National Forest in 1947 and 1955.

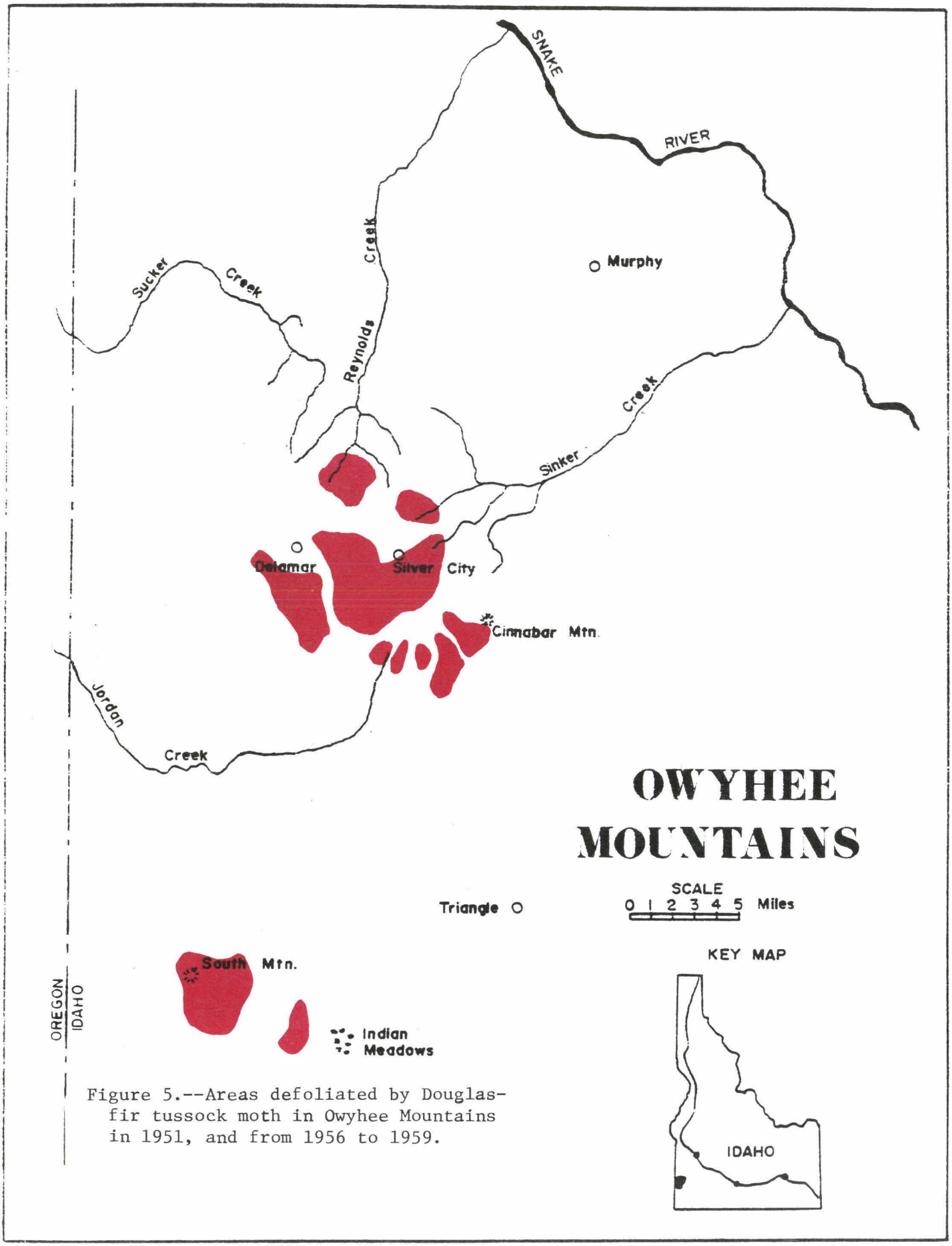

Figure 5.--Areas defoliated by Douglas-fir tussock moth in Owyhee Mountains in 1951, and from 1956 to 1959.

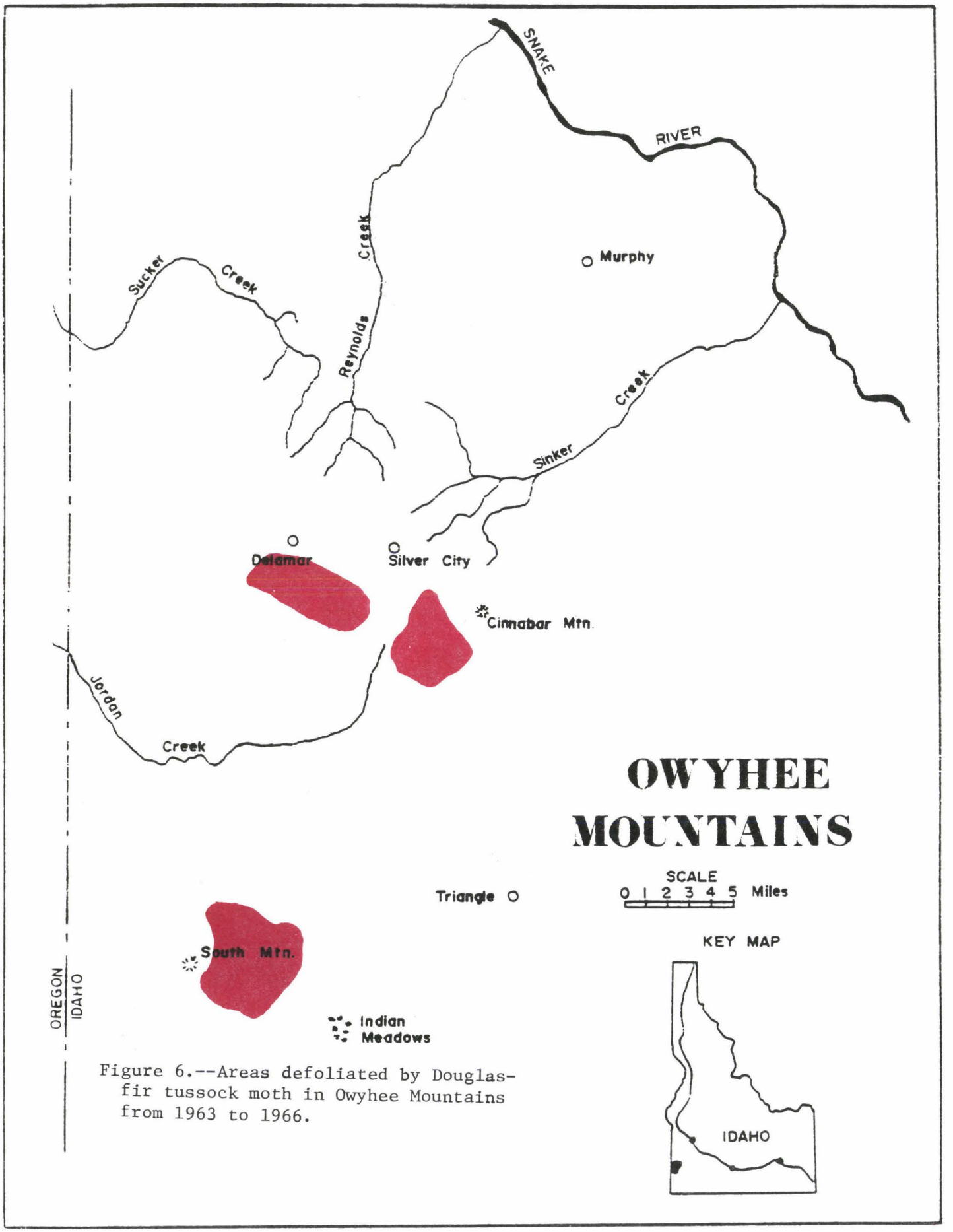

Figure 6.--Areas defoliated by Douglas-fir tussock moth in Owyhee Mountains from 1963 to 1966.

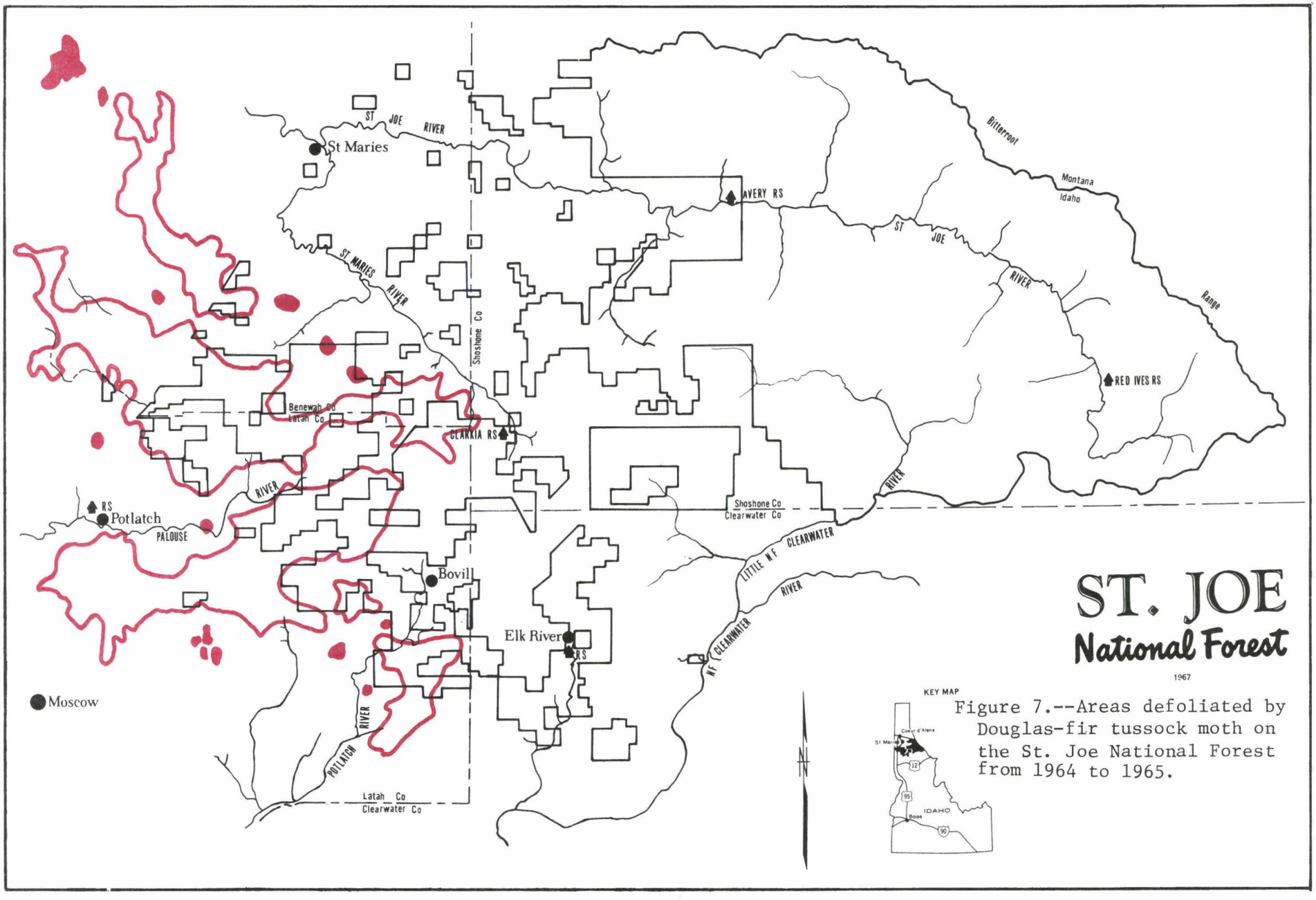

Figure 7.--Areas defoliated by Douglas-fir tussock moth on the St. Joe National Forest from 1964 to 1965.

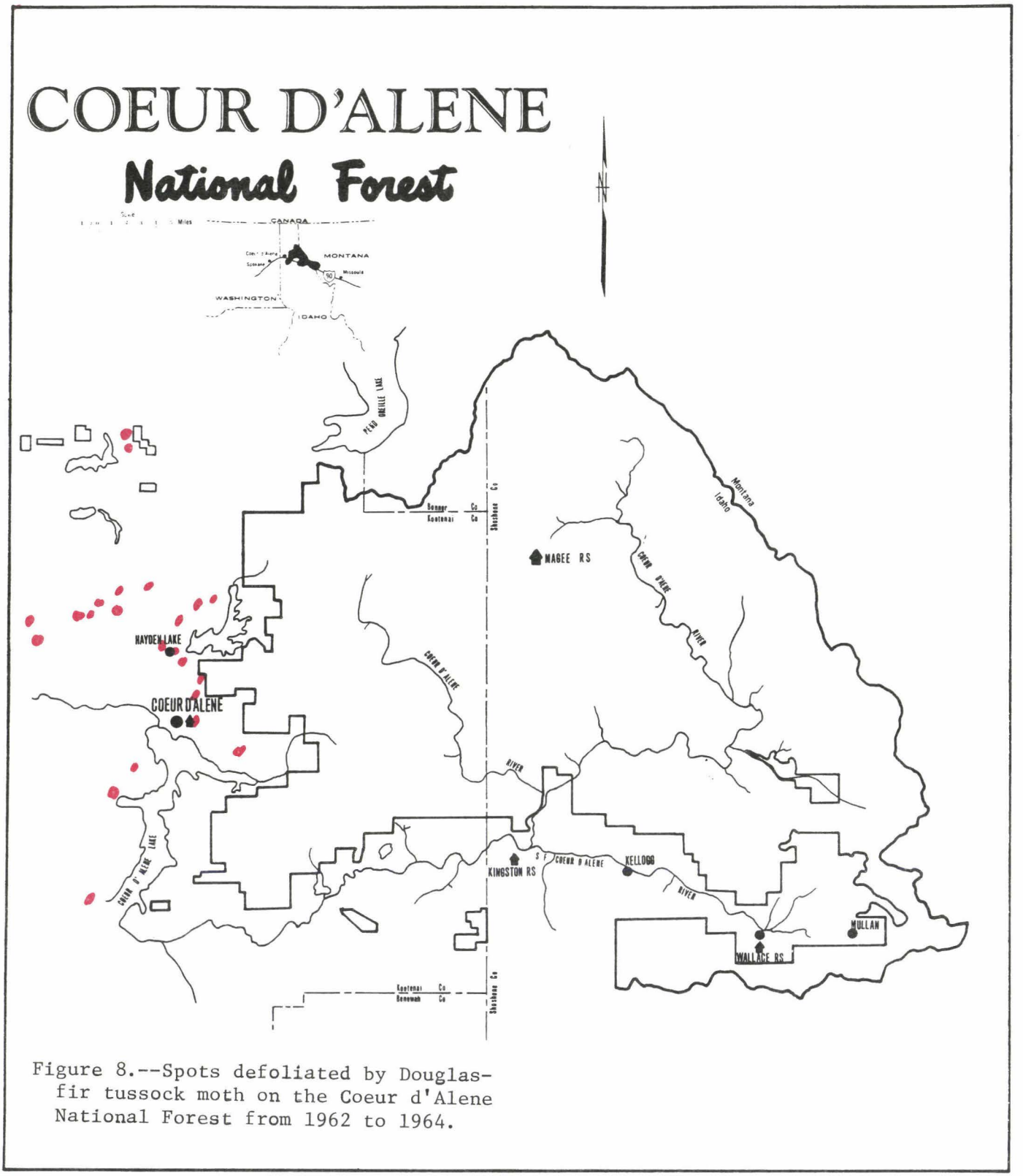

Figure 8.--Spots defoliated by Douglas-fir tussock moth on the Coeur d'Alene National Forest from 1962 to 1964.

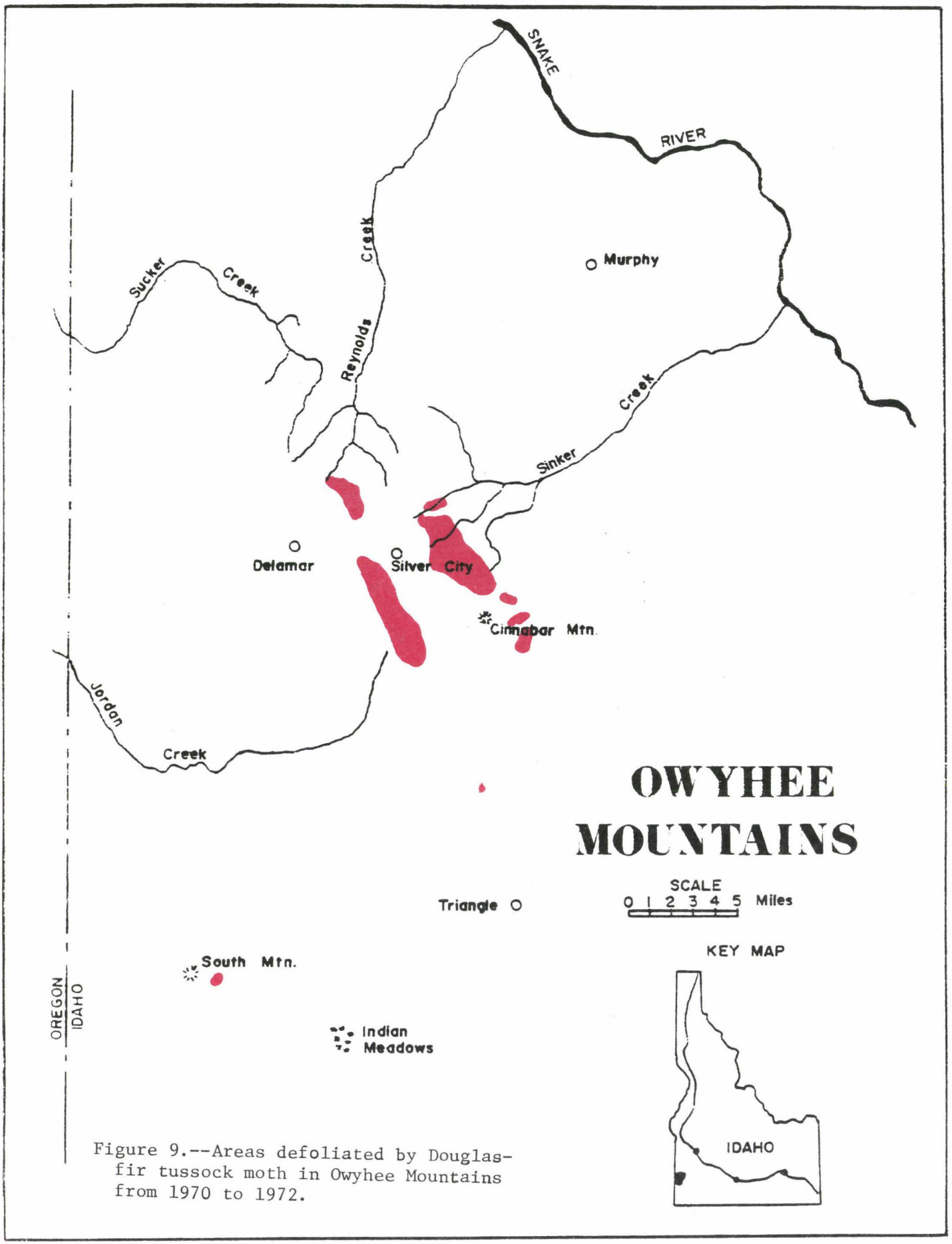

Figure 9.--Areas defoliated by Douglas-fir tussock moth in Owyhee Mountains from 1970 to 1972.

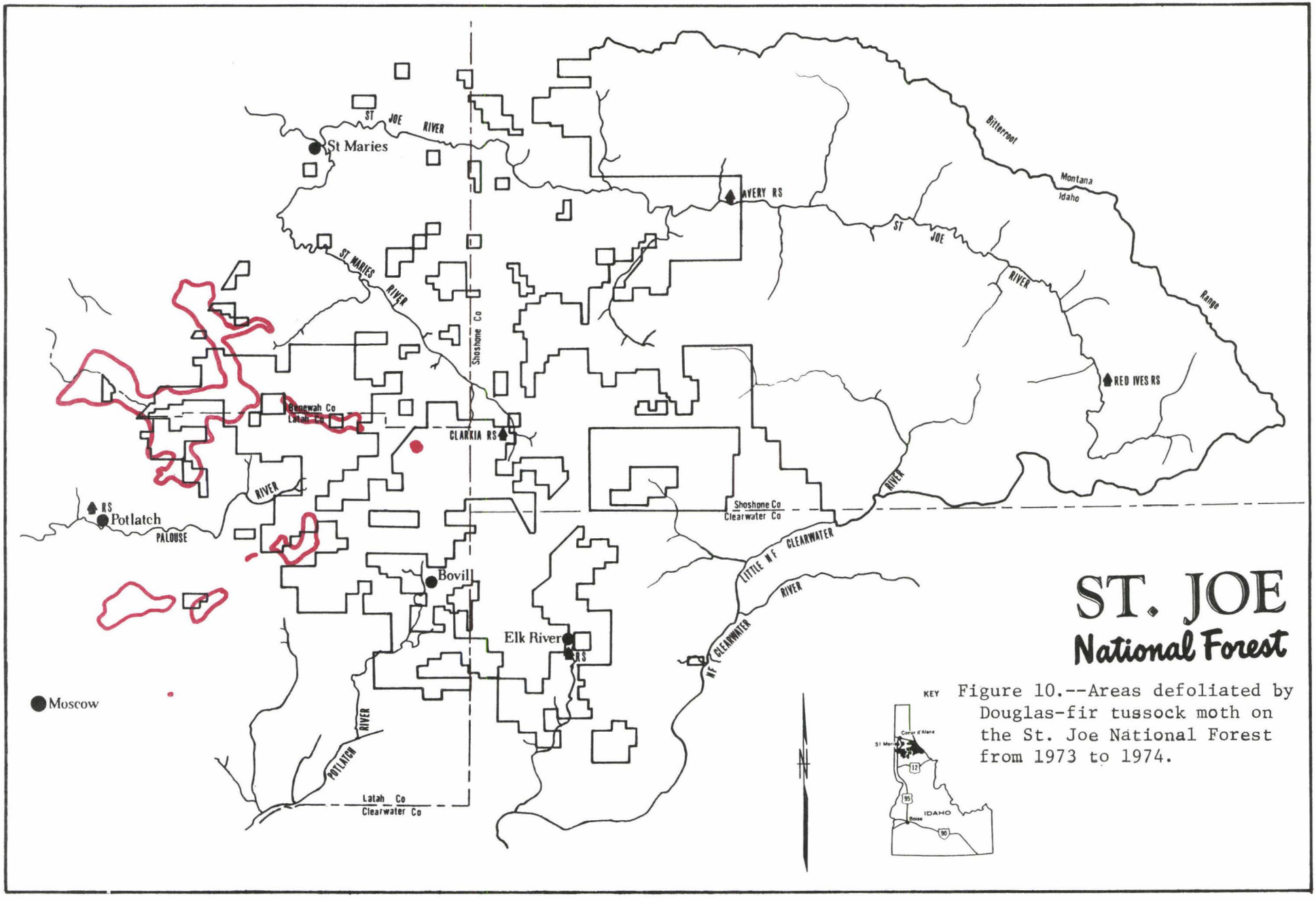

Figure 10.--Areas defoliated by Douglas-fir tussock moth on the St. Joe National Forest from 1973 to 1974.

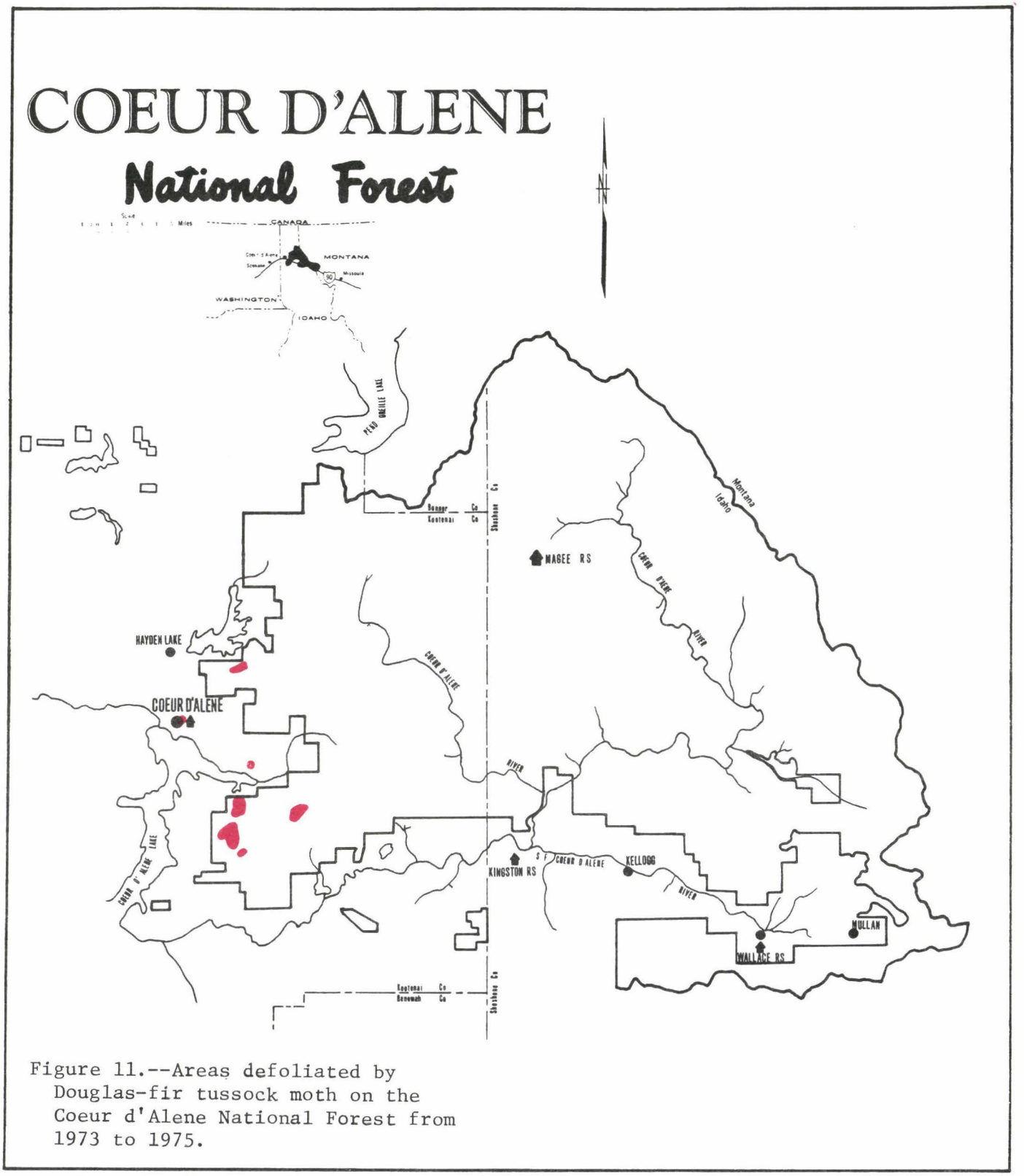

Figure 11.--Areas defoliated by Douglas-fir tussock moth on the Coeur d'Alene National Forest from 1973 to 1975.

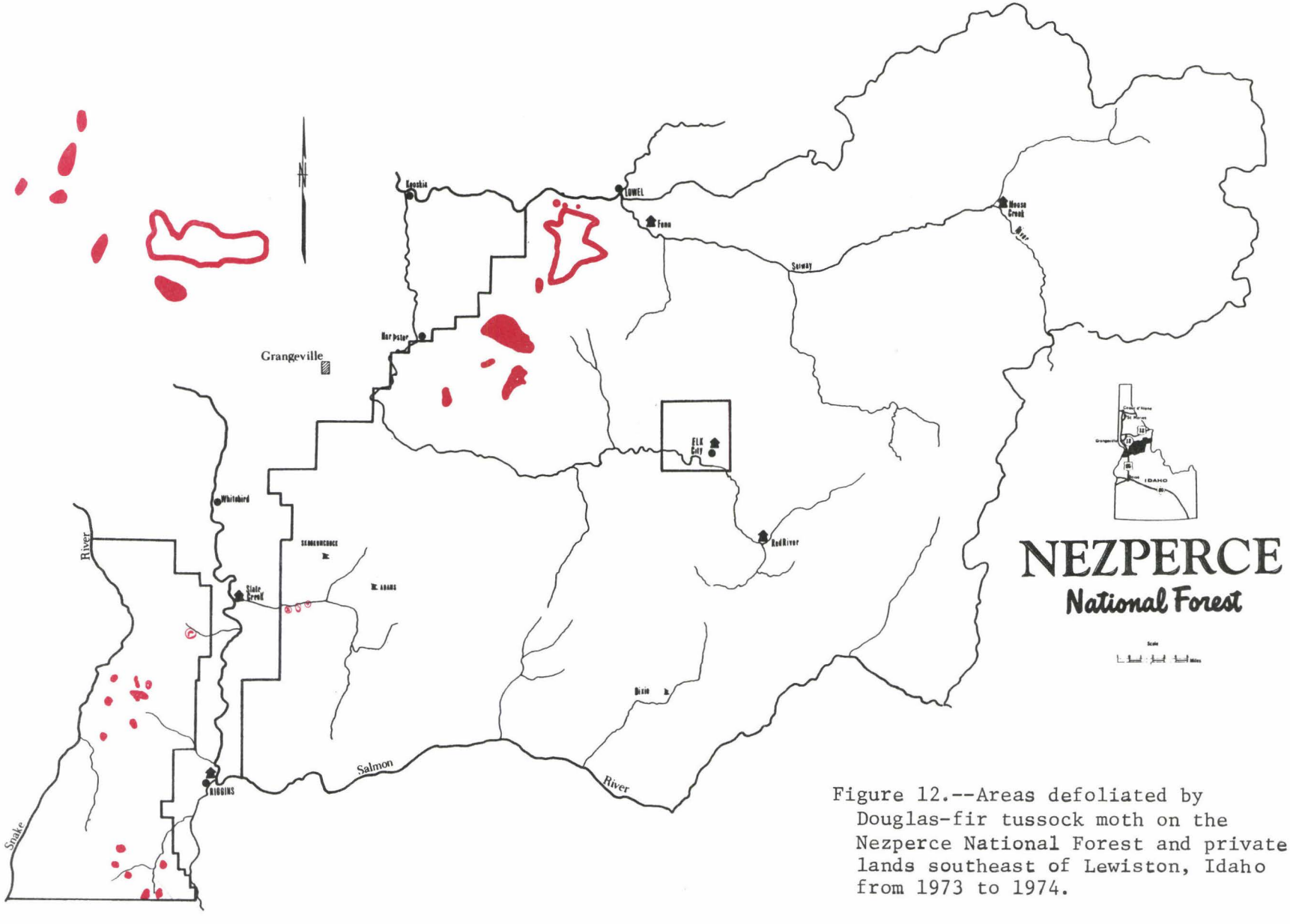

Figure 12.--Areas defoliated by Douglas-fir tussock moth on the Nezperce National Forest and private lands southeast of Lewiston, Idaho from 1973 to 1974.

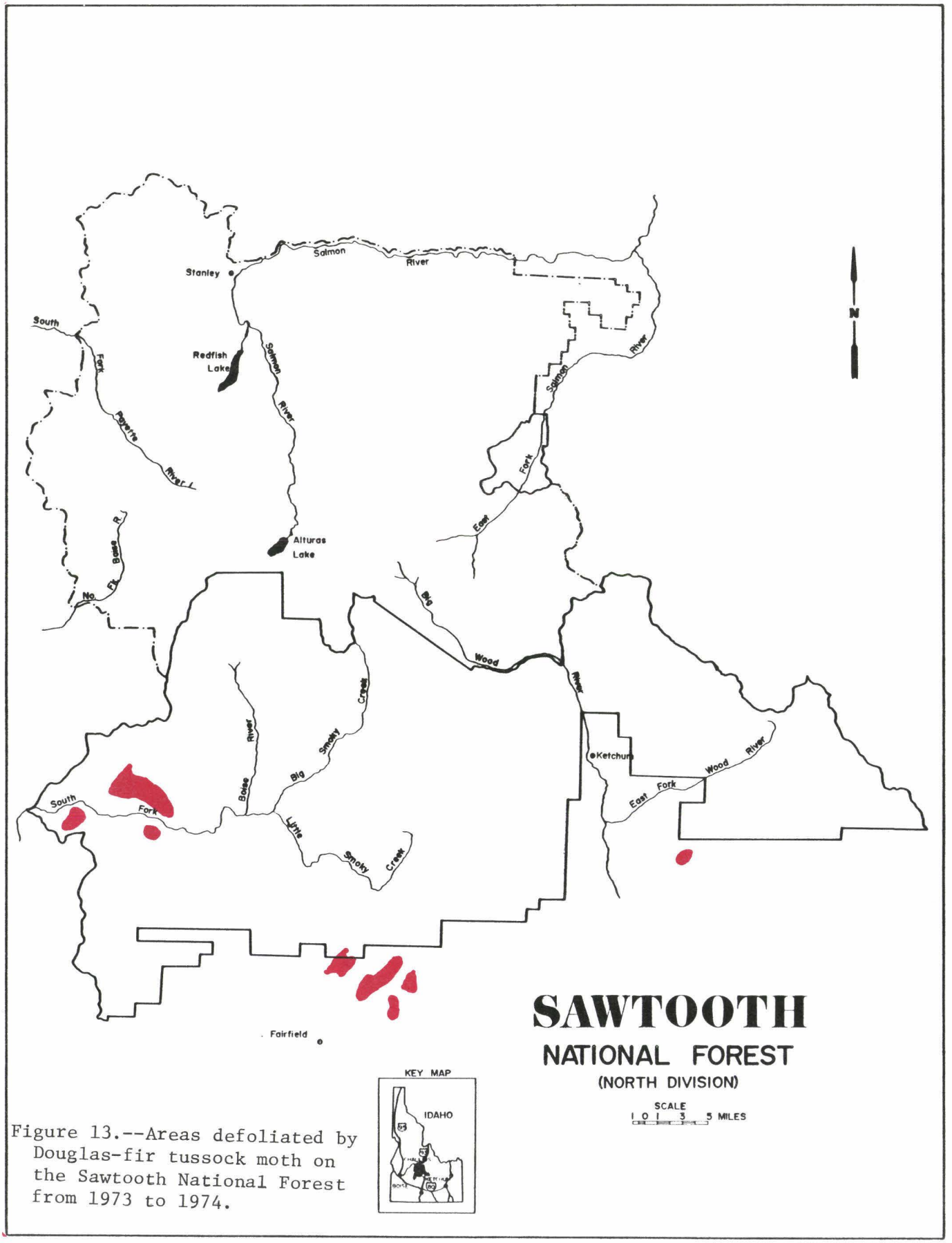

Figure 13.--Areas defoliated by Douglas-fir tussock moth on the Sawtooth National Forest from 1973 to 1974.

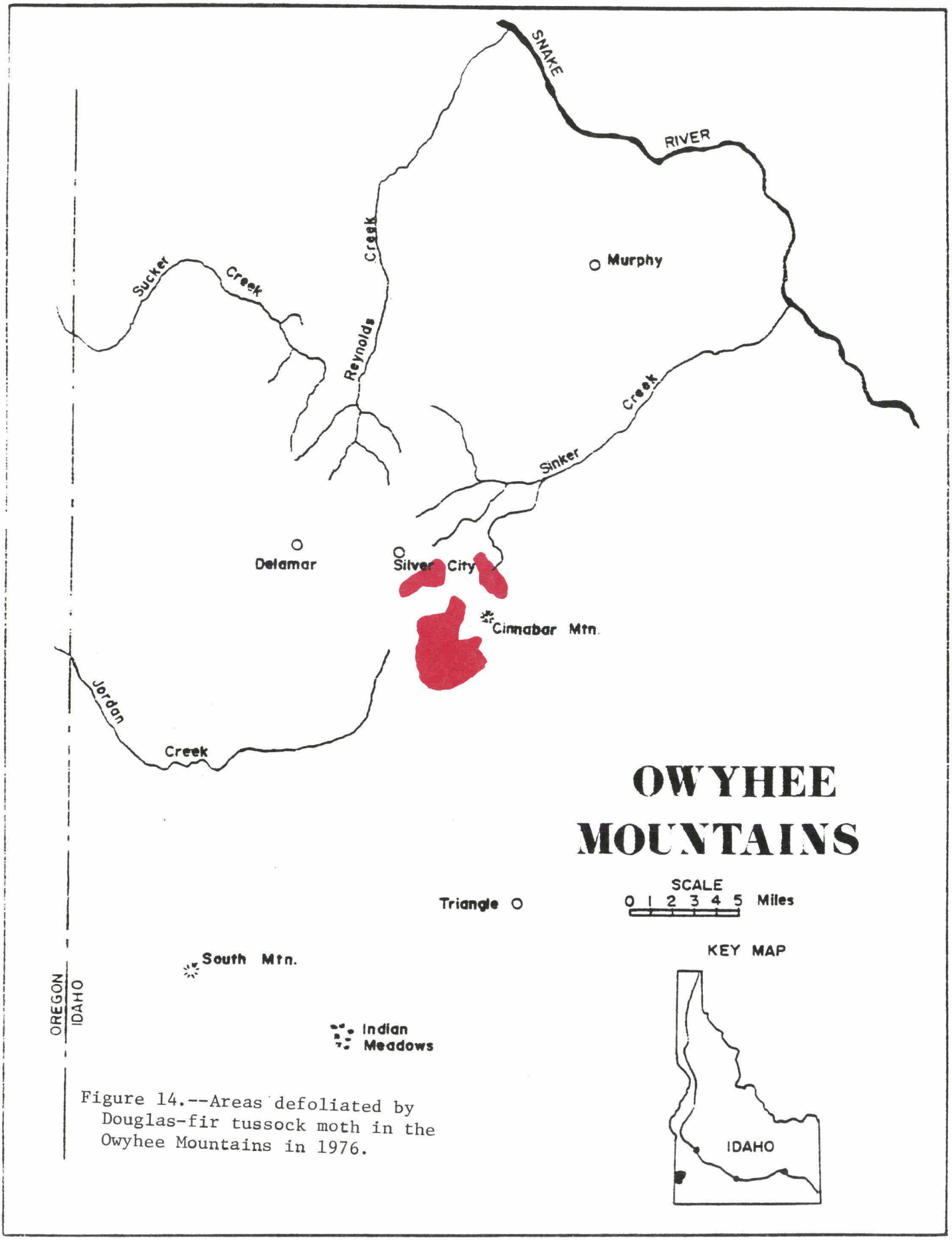

Figure 14.--Areas defoliated by Douglas-fir tussock moth in the Owyhee Mountains in 1976.

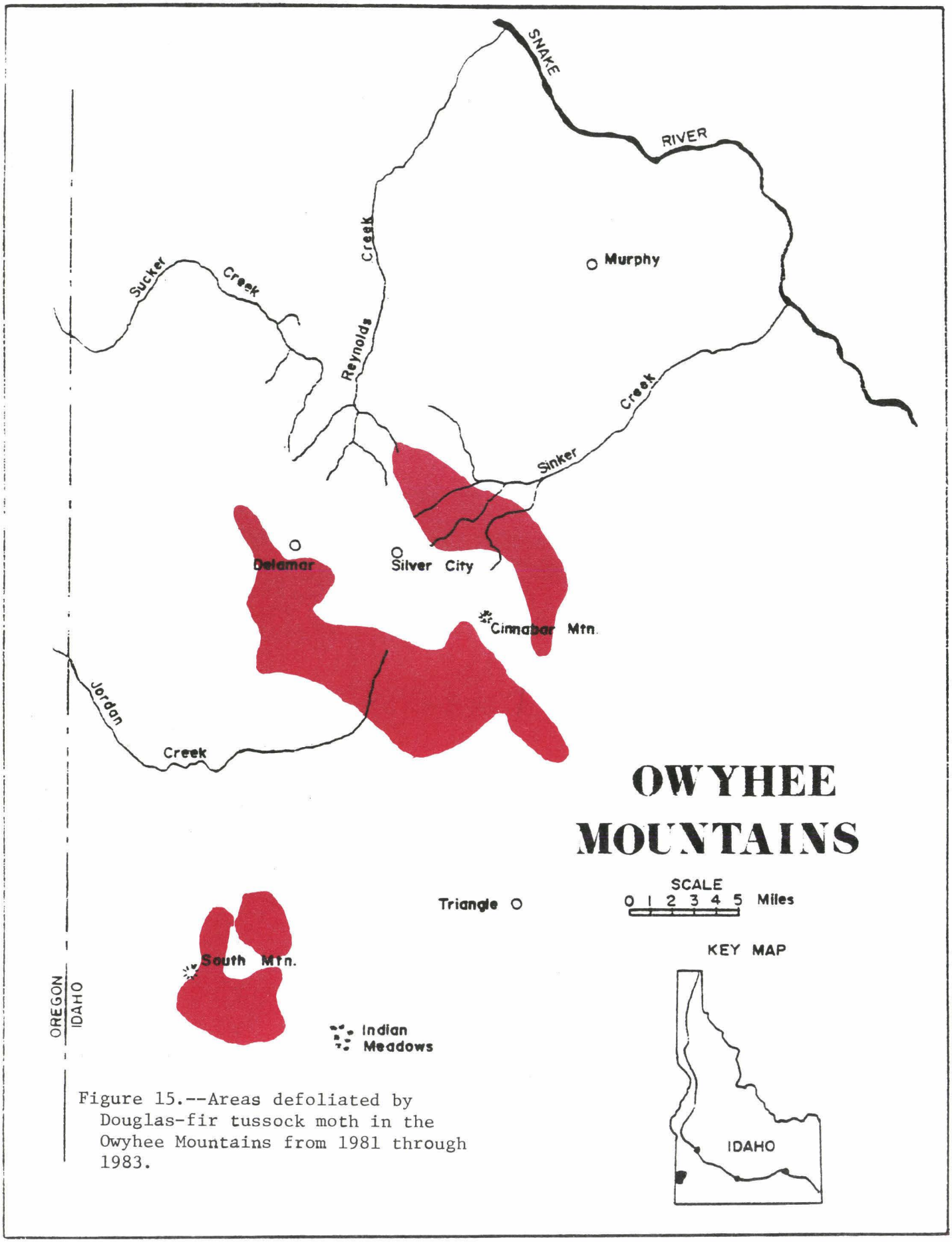

Figure 15.--Areas defoliated by Douglas-fir tussock moth in the Owyhee Mountains from 1981 through 1983.

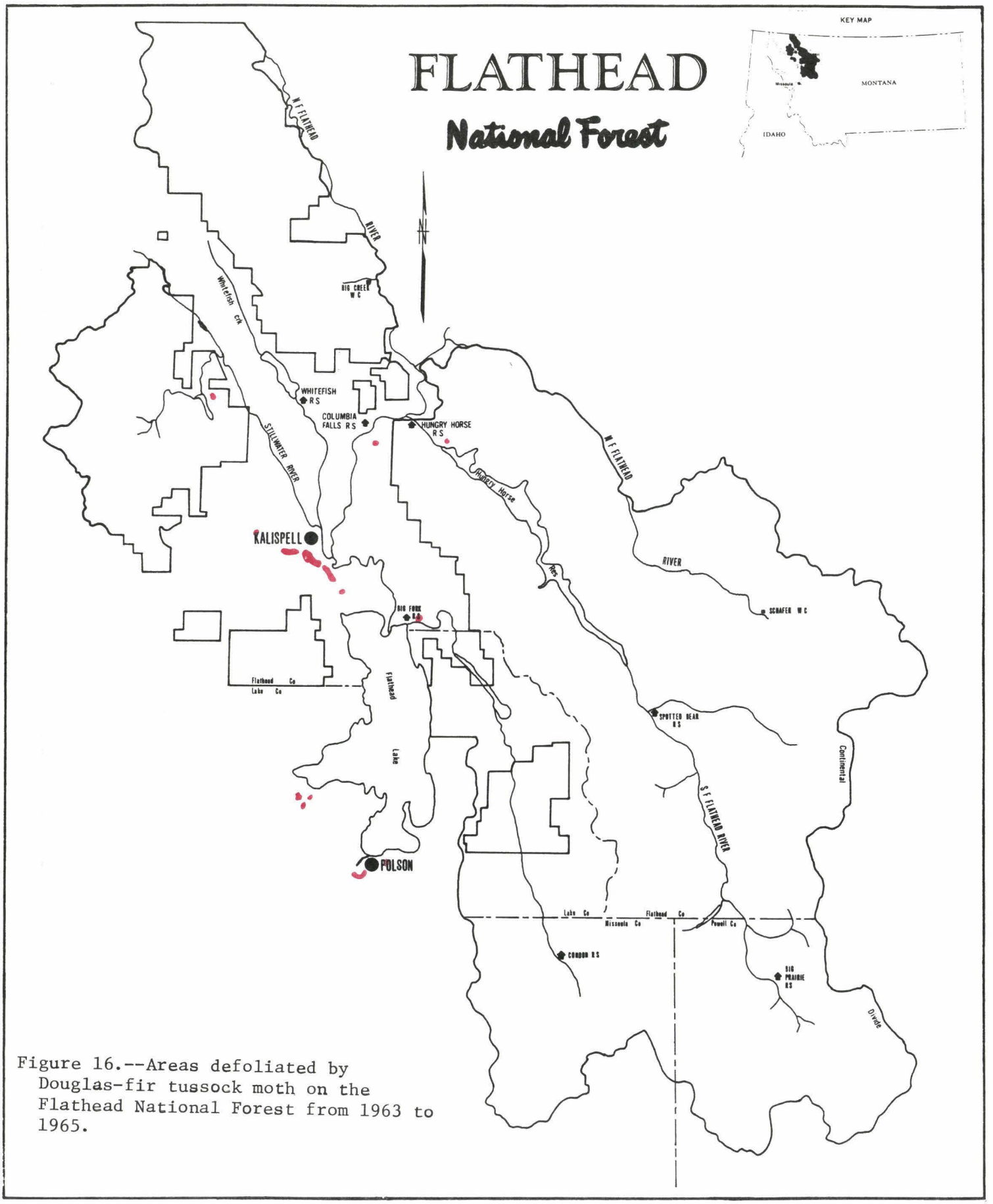

Figure 16.--Areas defoliated by Douglas-fir tussock moth on the Flathead National Forest from 1963 to 1965.

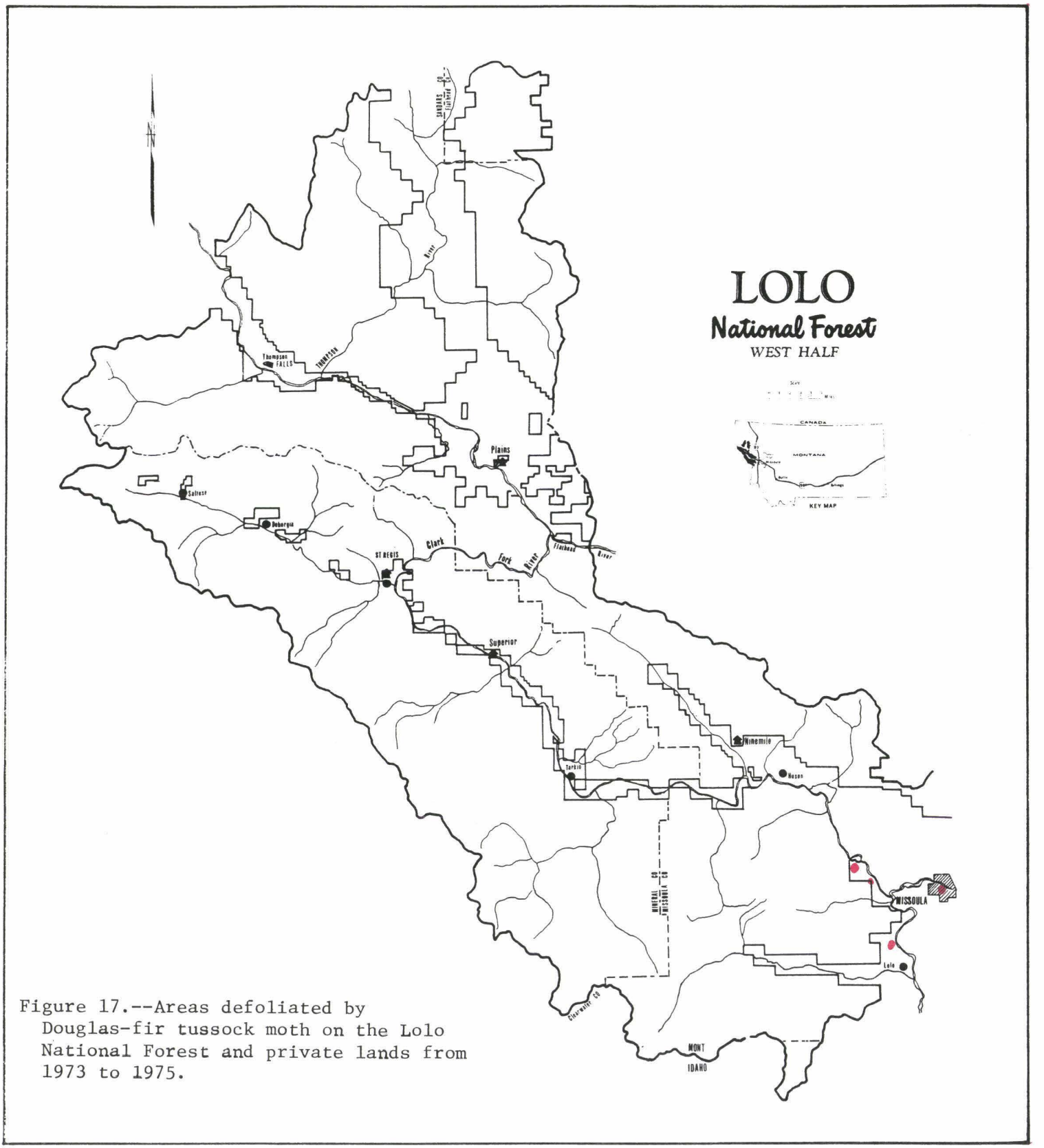

Figure 17.--Areas defoliated by Douglas-fir tussock moth on the Lolo National Forest and private lands from 1973 to 1975.

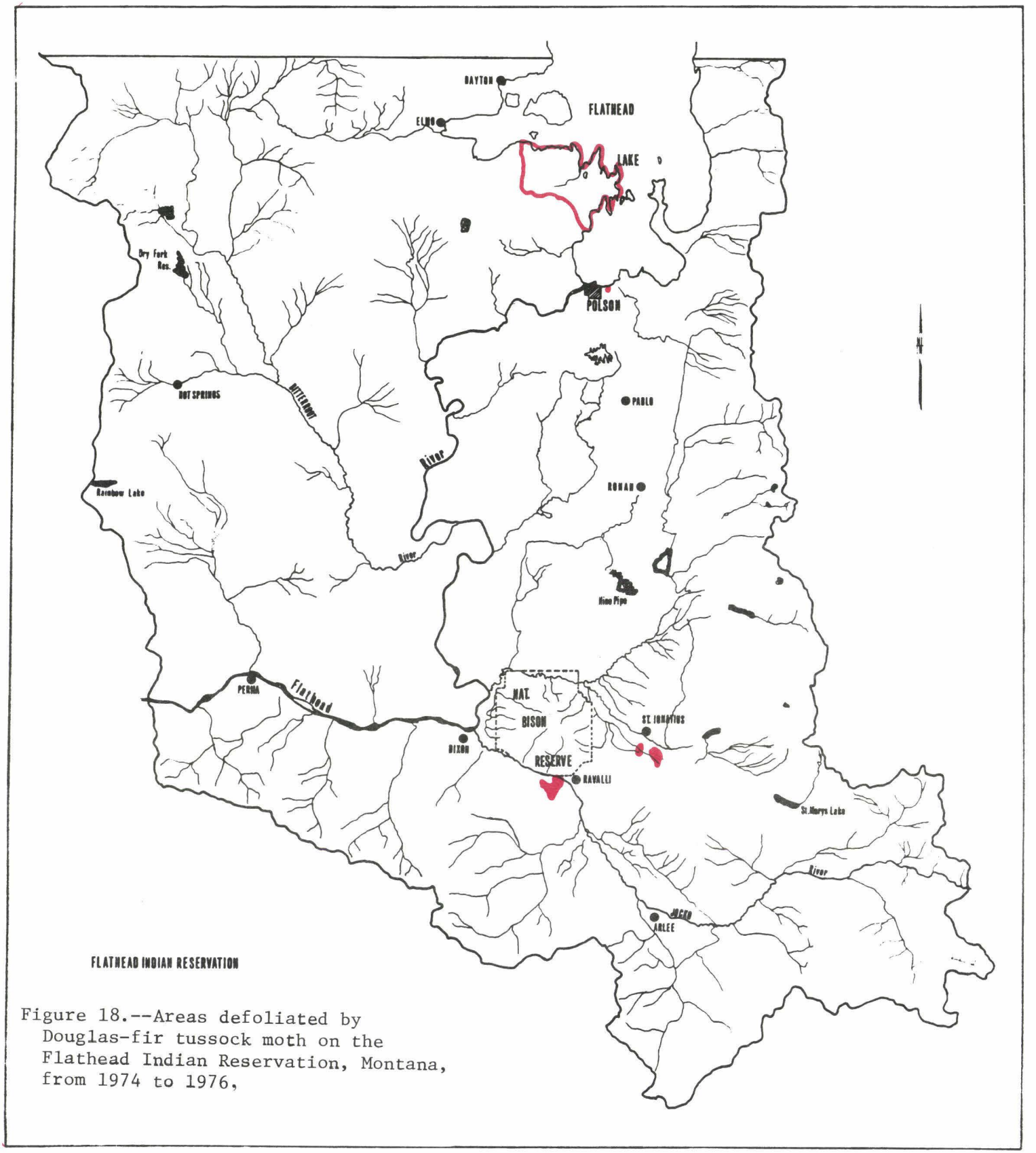

Figure 18.--Areas defoliated by Douglas-fir tussock moth on the Flathead Indian Reservation, Montana, from 1974 to 1976.

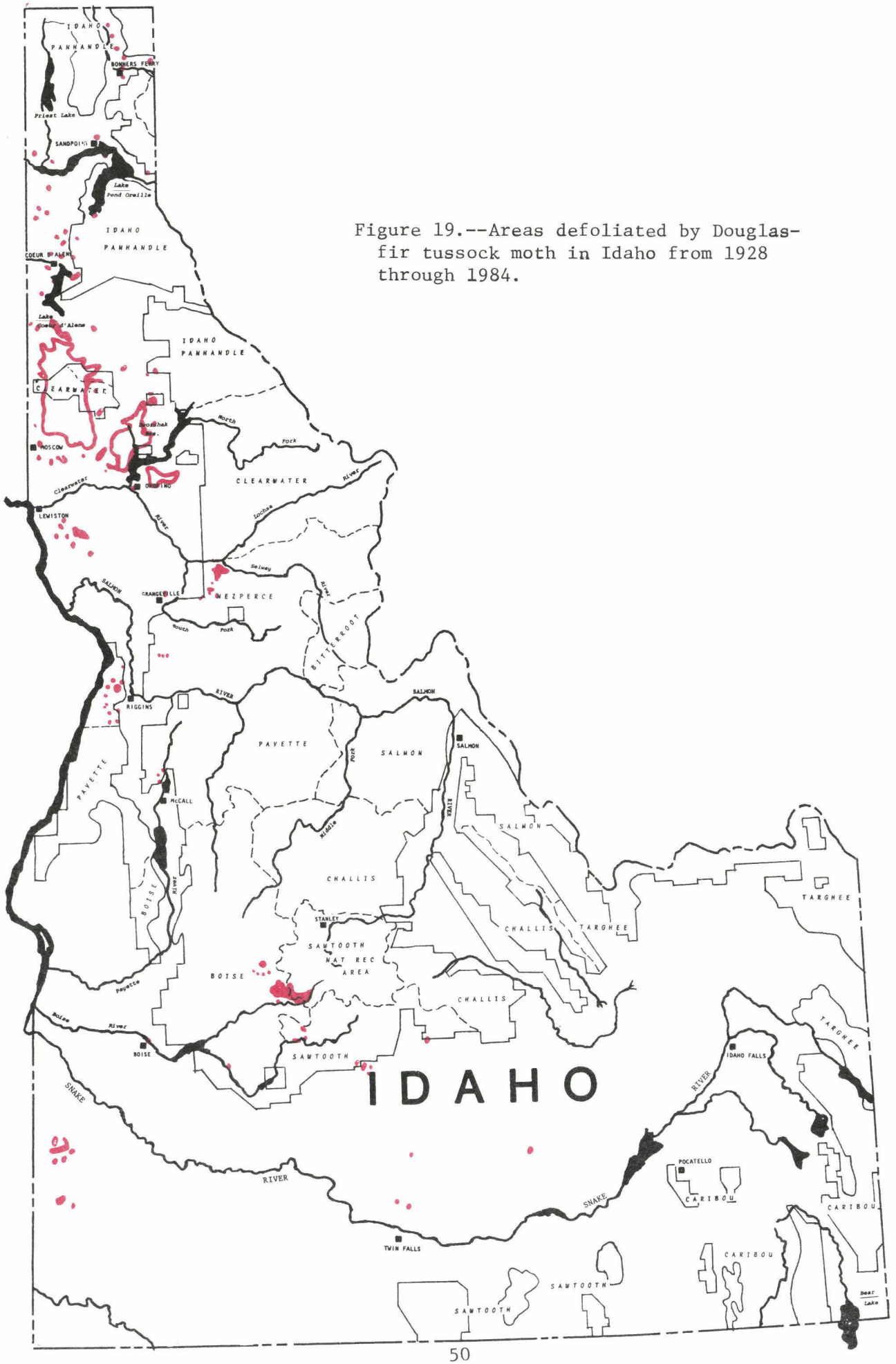

Figure 19.--Areas defoliated by Douglas-fir tussock moth in Idaho from 1928 through 1984.

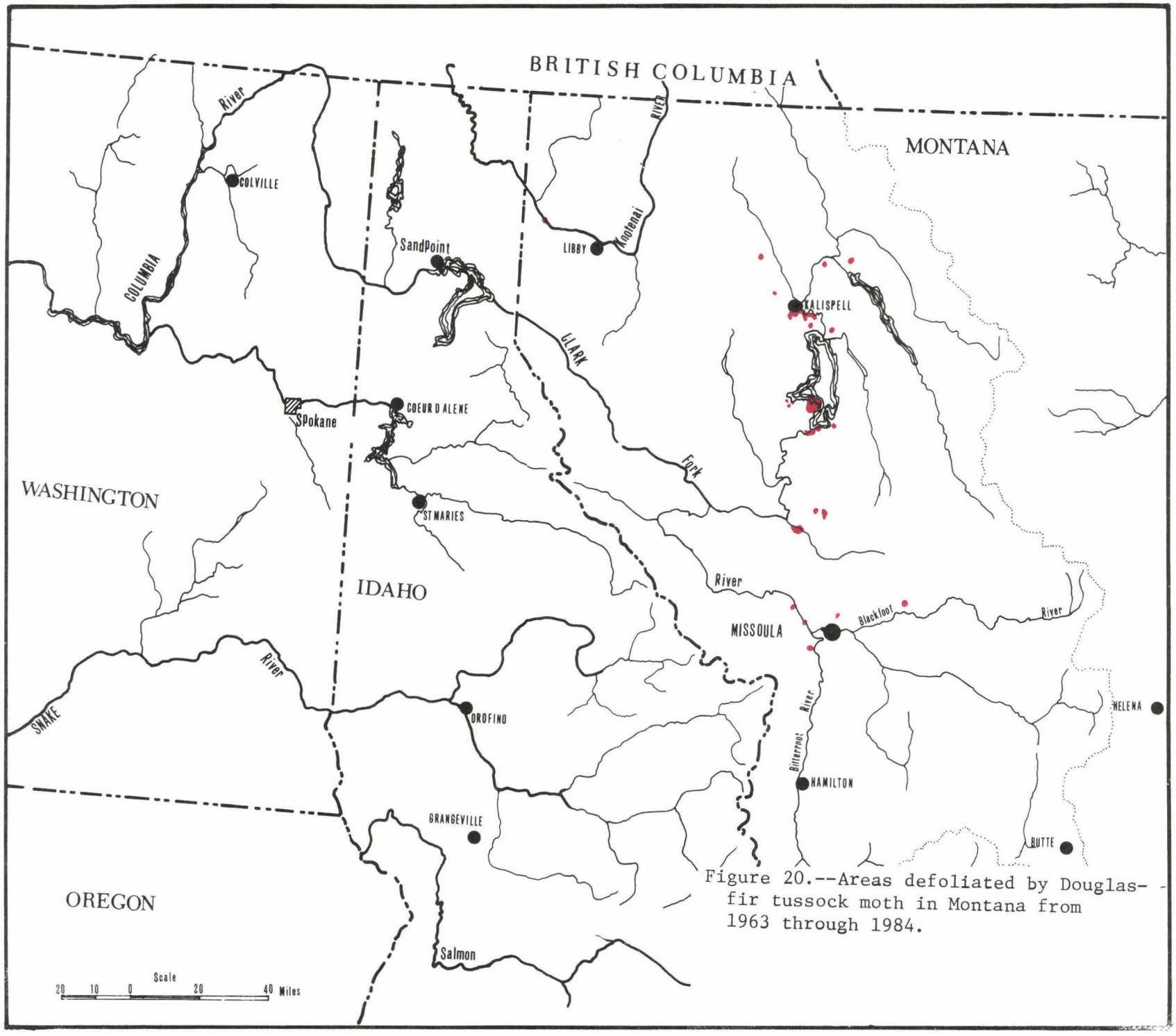

Figure 20.--Areas defoliated by Douglas-fir tussock moth in Montana from 1963 through 1984.

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